# Electrical Review

*THE PIONEER ELECTRICAL WEEKLY OF AMERICA*

VOL. XLII. No. 8. NEW YORK, SATURDAY, FEBRUARY 21, 1903. ISSUED WEEKLY

*ELECTRICAL REVIEW*

*13 to 21 Park Row* *NEW YORK*

BY THE

*ELECTRICAL REVIEW PUBLISHING COMPANY*

CHARLES W. PRICE . . . . PRESIDENT and EDITOR
STEPHEN H. GODDARD . SECRETARY and MANAGER
RUSSELL HOWLAND . GENERAL REPRESENTATIVE
WM. HAND BROWNE, JR. . . . TECHNICAL EDITOR
AINSLIE A. GRAY . . . . . ASSISTANT EDITOR

WESTERN OFFICE — 40 Dearborn Street, Chicago, Ill. CHARLES FFRENCH, Manager.

EUROPEAN OFFICE — 42 Old Broad Street, London, E. C. HENRY W. HALL, Manager.

TELEPHONE CALL (private branch exchange connecting all departments) — "21 Cortlandt."

REGISTERED CABLE ADDRESS — "Electview," New York.

*SUBSCRIPTIONS*

| | |
|---|---|
| One Year, United States and Canada | $3.00 |
| One Year, Foreign Countries | 5.00 |
| Single Copies, each | 10 |
| Copies supplied for only one year back, each | 25 |

*TO ADVERTISERS*

CHANGES for advertisements should be in this office by Friday noon for the following week's issue.

NEW ADVERTISEMENTS should be in the office not later than Monday noon to assure publication in that week's issue.

## *GOOD ROADS.*

The Good Roads Convention which met recently in Albany is doing good work and should have the support of all the electrical men. One, of course, thinks of the automobile first when the question of good roads is under discussion, but this is merely because the novelty of the automobile has not yet worn off. But good roads will have a far-reaching effect upon the general prosperity of the state and country. The benefits to the farmers are obvious, and the increased value of real estate which will follow road improvement should not be overlooked. That the electrical industries will benefit as well from the good-roads movement we do not doubt, and we are confident that this movement will receive the hearty support of all electrical interests.

## *COOPER HEWITT'S WIRELESS TELEGRAPH DEVELOPMENT.*

On another page of this issue will be found a description of a new application of the mercury vapor tube. This is its action as an interrupter, which enables it to be used to set up electrical oscillations, for which purpose it will take the place of the various types of interrupter now employed. The action of the tube depends upon two properties which make it particularly suitable for this work—that is, the so-called negative electrode resistance opposes a flow of current through the tube until a certain high-potential difference exists across the lamp. At this point resistance practically disappears, so that the tube forms a low-resistance circuit across the condenser and allows the latter to discharge at a very high rate. When, during this discharge, the difference of potential across the tube has fallen to a low value, the initial cathode resistance reappears and checks the discharge. At this instant the source of supply begins to recharge the condenser at a rate depending upon the power of the supply and the constants of the circuit. We have, then, an interrupter of low resistance which, by its action, may cause the condenser to charge and discharge at a very high rate.

*Assistance in Studying Electrical Waves.*

The importance of this device will be recognized at once, and it will certainly be put to many uses. It will prove a powerful weapon in the hands of physicists studying electrical waves; but probably the most striking and important application just at this time will be its use in wireless telegraphy.

*Selective Wireless Telegraphy.*

The method now employed to set up oscillations in the sending circuit of a wireless telegraph station consists of a discharge of condensers across an air-gap; but this method gives rise to oscillatory discharges of such a character that it is practically impossible to tune a receiver to them, and since the resistance of the spark-gap is high, the power which may in this way be radiated is comparatively small. The Cooper Hewitt mercury vapor interrupter, however, gives continuous impulses of equal amplitude. The frequency of these will be predetermined precisely by the constants of the circuit, so that selective telegraphy will not only be possible, but easy. That is to say, there will be no difficulty in tuning a receiving circuit to respond to a given frequency.

*Secrecy.*

To preserve secrecy it is, of course, necessary to prevent other stations from tuning their receiving circuits to the selected frequency. This can be done by varying the frequency of transmission—that is to say, each system may have a frequency code. When a message is to be sent out the transmitting station will signal this fact to the proper receiving station, and will indicate the particular frequency which will be used. By the throw of a switch the receiving station can be tuned to that frequency and will receive the message. In the short time which elapses during the sending of the message—or, rather, during which this one frequency will be used—it will be practically impossible for any other receiving station at which the code is not known to tune its circuits to the, to them, unknown frequency.

*Range of Transmission.*

Furthermore, since the impulses established by the Cooper Hewitt interrupter are regular and continuous, their action will be far more effective on a properly tuned receiving circuit than the irregular discontinuous impulses which are being used to-day. It would seem, therefore, that the use of this interrupter will in-

crease greatly the possible range of transmission.

*An Authoritative Opinion.*

In discussing the importance of this device recently, Dr. Michael I. Pupin, professor of electromechanics at Columbia University, and widely known from his inventions in telephonic transmission, said to the editor of this journal: "The Cooper Hewitt mercury vapor interrupter at once establishes wireless telegraphy on a commercial basis. The problem of selective signaling is solved, and transatlantic transmission will be easy."

## ELECTRONS.

The electron theory of electricity, about which so much has been written of late, was discussed at a meeting of the British Institution of Electrical Engineers last December by Sir Oliver Lodge, with his customary skill and clearness. Sir Oliver has the faculty of explaining difficult subjects in a way not only to hold the interest of his hearers, but to make the matter comprehensible to all.

*Atoms and Electrons.*

This paper was a long one, and is now appearing in abstract form in the ELECTRICAL REVIEW. We will not touch upon the beautiful and ingenious methods by which this theory has been reached. The results certainly seem incontrovertible. To sum up, this hypothesis assumes that atoms are made up of small particles of matter oppositely charged. Though the positive electron has not yet been discovered, it does not seem likely that it will be able to hide itself much longer. The number of these electrons composing an atom varies according to the material, a hydrogen atom having about 700, and an atom of mercury about 100,000. In the later case it must not be assumed that the electrons are closely crowded together. Indeed, it is computed that the space not occupied by these bodies in an atom of mercury is ten thousand million times that taken up by the particles. It will be seen from this that these little bodies are separated from each other by distances relatively astronomical. In fact, each atom constitutes a little universe of its own.

*Electrical Theory of Matter.*

So far as known, electrons thrown off by different materials are identical, this pointing to a primal element, elements, such as we know them, being formed of stable groupings of electrons. The electron itself may be considered as the atom of electricity.

*Lines of Future Research.*

After cornering the positive electron, the next move should be to see whether an atom can be broken up, and if so, what happens. Then it will be in line to attempt to break up an electron.

The picture drawn by Sir Oliver of a vagrant electron being caught and attached to an atom over which it wanders until allowed to hop away by a ray of ultra-violet light, or other means, reminds one of the old rime:

> Big fleas have little fleas
> Upon their backs to bite 'em,
> Little fleas have lesser ones,
> And so *ad infinitum*.

## PRODUCER GAS.

Recently we referred to the need for a better way of supplying fuel to city residences, and called attention to the nuisance caused by hauling and burning coal. It was suggested that a more general use of gas for this purpose might be expected, and that it seemed desirable for the gas companies to work up this field.

*Saving in Fuel by the Use of Gas.*

Recently Mr. H. A. Humphrey delivered a lecture before the London Chamber of Commerce, in which he takes the same stand. In the course of this it was stated that by using the cheaper form of gas, known as "producer" gas, at least one-half of the total consumption of coal would be saved, this result being due to the greater efficiency of gas over coal as a fuel.

*Method of Manufacture.*

Producer gas is formed by passing steam and air through a thick bed of coal. In this way all the coal is consumed, the greater part of the carbon being converted into carbon monoxide, though a small amount of carbon dioxide is formed. There is also nitrogen present in considerable quantity, mixed with hydrogen and menthane gas. In the process, as the coal is entirely consumed, leaving nothing but the ash, there is no coke resulting from the treatment. There are, however, by-products, such as sulphate of ammonia, which have a commercial value.

*Calorific Value.*

Producer gas has a smaller calorific value than illuminating gas, but this is more than offset by the greater quantity of gas formed by this treatment. Thus, it is asserted that one ton of coal will yield 10,000 feet of illuminating gas, but will give 150,000 cubic feet of producer gas. So, although the illuminating gas has a calorific value of about four times that of the producer gas, the final product gives the latter a value about four times that of the former.

*Advantages of Gas.*

The advantages of gas are not confined to economy of fuel and the avoidance of the smoke nuisance and dust and dirt. By its use labor is very materially reduced, it is easily controlled, repairs to furnaces should be minimized, and temperatures can be regulated with certainty and ease. There is less waste of material and more uniform results may be obtained.

*Field for Application.*

Producer gas has come into use for gas engines. These prime-movers have a much better thermal efficiency than the steam engine, and as they have proved their ability to operate under the severest conditions, they seem likely to be used more generally. It would seem that there is a field for gas companies to furnish this kind of fuel, not only for power purposes, but for household use as well. It is not probable that the gas engine will take the place of the electric motor, but there may be some instances where it will seem more suitable. At all events, there is certainly a chance for improvement in our fuel supply, and a cheap fuel such as producer gas would do much toward accomplishing this reform, and the development of this business would seem to be a profitable undertaking.

## *ON ELECTRONS.*[1]

BY SIR OLIVER LODGE.

### DETERMINATION OF THE MASS OF AN ELECTRON.

So far, all the measurements quoted have resulted in a consensus of certainty respecting our knowledge of $e/m$ for gaseous conduction and radiation; and the measurements made on the cathode rays in a Crookes tube, or near a plate leaking in ultra-violet light, have likewise given us a knowledge of the velocity, and shown that it is about one-thirtieth of the velocity of light, more or less, according to circumstances. But so far no direct estimate has been made of either $e$ or $m$ separately. The difficulty of making these measurements is great, because we are dealing with an aggregate of an enormous and unknown number of these bodies. It would not be difficult to make a determination of the aggregate mass of a set of projectiles, say N $m$, where N is the number falling on a target in a given time, by means of the heat which the blow generates; or, better, perhaps, by the momentum which they would impart to a moving arm after the fashion of a ballistic pendulum; provided their velocity, $u$, was known, as in this case it is. The aggregate energy, $\frac{1}{2}$ N $m u^2$, or the aggregate momentum, N $m u$, could thus be found, but how is $m$ to be separated from N?

Again, if the particles are collected in a hollow vessel attached to an electrometer of known capacity, it is not difficult to estimate the total quantity of electricity which enters the vessel in a given time; that is to say, to determine N $e$; but, again, how are we to discriminate $e$ from N?

We may consider the following quantities experimentally determined by researches carried on at the Cavendish laboratory and elsewhere, and so far already described or indicated:

$e/m$

$u$

N $e$

N $m$

See previous abstract of Part III for measurements of these quantities for the case of cathode rays.[2]

Another thing that is comparatively easy to determine, especially in such cases as leak from a negative surface under the action of ultra-violet light, or the conductivity of air induced by the impact of Rœntgen rays, is the total current transmitted.

If only it were now possible to count the corpuscles or electrons, to determine the number N which are started into existence, or which enter the hollow vessel, or which take part in conveying the current in the case of a leak by ultra-violet light, we should no longer have to guess at the actual value of $e$ and of $m$ separately, but should have really determined them.

This brilliant research has actually been carried out by Professor J. J. Thomson, by means of a method partly due to Mr. C. T. R. Wilson, supplementing a fact discovered by Mr. Aitken, and interpreted in the light of a hydrodynamic theorem arrived at long ago by Sir George Stokes.

### AITKEN AND CLOUD NUCLEI.

Mr. John Aitken,[1] of Edinburgh, discovered in 1880 that cloud or mist globules could not form without solid nuclei, so that in perfectly clear and dust-free air aqueous vapor did not condense, and mist did not form. (See, for instance, my lecture to the British Association at Montreal in 1884, on "Dust"—*Nature,* vol. xxxi, p. 268).

Without solid surfaces, in clear space, vapors could become supersaturated; but the introduction of a nucleus would immediately start condensation, and according to the number of nuclei, or condensation centres, so will be the number of cloud globules formed.

Every cloud or mist globule is essentially a minute rain drop, not floating in the least, but falling through the air—falling slowly because it is of such insignificant weight and is moving in a resisting medium—but falling always relatively to the air.

### J. J. THOMSON AND ELECTRICAL NUCLEI.

In 1888 it was shown by J. J. Thomson, in his book "Applications of Dynamics to Physics and Chemistry," p. 164, that electrification of a body would partially neutralize the effect of curvature, and so assist the condensation of vapor on a convex surface, and a sufficient electric charge might cause it to condense on quite a small body—as small even as an atom, or smaller. Hence, in the presence of electrified ions or electrons, dust particles are not necessary for condensation. Vapor may condense on these electrical nuclei without the need for solids of finite curvature.

While ions or electrons are present in considerable numbers a thick mist will form whenever the space is saturated with vapor, but it will be a mist of different appearance from the slight rain-like condensation which may be seen forming around the few residual dust particles. The mist globules will usually be of uniform size, and some estimate of that size can be roughly attempted by the diffraction colors which can be seen if a point of light is looked at through the mist; not, however, a very easy plan of making a trustworthy estimate.[1]

### WILSON AND METRICAL CLOUD CONDENSATION.

Mr. C. T. R. Wilson,[2] in his study at the Cavendish laboratory of cloud formation under the influence of Rœntgen rays and by other methods, devised a plan for precipitating a definite and known quantity of aqueous vapor in a visible form. This was done by an arrangement for making a sudden or adiabatic expansion of saturated air, and making it to a carefully measured amount. The mist at once formed, and the drops began to fall slowly, as usual. Mr. Wilson tried to get an estimate of their size from the colors, but it was difficult and unsatisfactory.

It occurred to J. J. Thomson that a better estimate of size could be made by observing their rate of falling, which is a thing not difficult to observe since they all fall together, being all of the same size. In any mist formed in a bell-jar it is easy to watch it settling down by watching its fairly definite upper surface, a clear space being left above it which gradually increases in thickness as the cloud falls. The rate of movement of the top of the cloud will give the rate of falling of the individual globules of which it is composed.

### PROFESSOR STOKES AND FALLING SPHERES.

Many years ago, in 1849, Sir George G. Stokes[3] discussed the motion of solids through fluids, and among others of a sphere moving through a viscous fluid urged by its own weight. It is a familiar fact that large bodies fall through air or water or any resisting medium more quickly than small ones of the same shape. Large raindrops fall violently, small raindrops fall gently, and mist globules hardly fall at all—fall so slowly that their motion is difficult to observe—but the same law governs all so long as the motion is not too violent, or so long as the falling body has no edges such as will cause eddies during the fall. A sphere falling slowly, controlled by viscosity alone without waves or eddies, is the simplest case. It

[1] Abstract of Parts V and VI of a paper read before the British Institution of Electrical Engineers. Parts I to V have been abstracted.

[2] J. J. Thomson, *Phil. Mag.*, October, 1897.

[1] *Trans. R. S. Edin.*, 1880.

[1] See C. T. R. Wilson, *Phil. Trans.*, 1897, A. vol. clxxxix, p. 288.

[2] *Phil. Trans.*, A, 1897, vol. clxxxix, p. 265.

[3] *Camb. Trans. Phil. Soc.* ix, 48.

soon reaches what is called a terminal velocity—the speed at which the viscous resistance exactly balances its weight.

### J. J. THOMSON'S EXPERIMENT OF COUNTING.

We have now all the materials ready for understanding the experiment to be performed,[1] so as to count the ions which are produced in air under the impact of Rœntgen rays, or when there are electrons to be counted which have been produced from a negatively electrified surface illuminated with ultra-violet light. A clean zinc surface in vacuo, faced by a water surface through which the light could shine on it, and by a window of quartz which makes the vessel airtight, so that it might be exhausted and yet allow the ultra-violet light to pass, was employed.

The rate of leak which gives the current $N\ e\ u$ is determined by connecting the water and the zinc plate to the terminals of an electrometer, the zinc plate being kept negative by means of a battery of a sufficient number of cells.

And now, supplying this apparatus with the adiabatic expansion appliances of C. T. R. Wilson, metrical condensation can be produced, a mist will form, and the rate of its fall can be observed, whence by Stokes's theorem the size of each globule is known; the quantity of water which had gone to form globules is known from the measured amount of expansion, and so the number of such globules, and therefore the number of their condensation centres or nuclei or ions, can be determined.

The number of drops found in a certain experiment by this means was about 30,000 to the cubic centimetre; the total quantity of water which went to form them being about the two-hundredth part of a milligramme.

### RESULT.

The result of the execution of this ingenious counting process is that the absolute charge and the absolute mass of an electron are at length directly determined. Hitherto we have determined by many and various ways the ratio $e/m$ and the speed $u$. We have likewise been able to determine $N\ e\ u$ and $N\ e$ and $N\ m\ u^2$, as already explained.

Now at length we have determined N, and at once the terms in the ratio $e/m$ are disentangled.

$e$ comes out, as suspected, in all cases, the regular ionic charge of the order of magnitude $3 \times 10^{-10}$ electrostatic, or $10^{-20}$ electromagnetic units; hence $m$ comes out for positive carriers and for ions the appropriate mass of the atoms present. In some cases the masses are greater than this and represent molecular aggregates. But for the negative carriers set free by ultra-violet light, and for the other cases where $e/m = 10^7$, the masses come out definitely of the order $10^{-27}$ grammes, or about one seven-hundredth part of the smallest and lightest previously known quantity of matter, *viz.*, an atom of hydrogen.

The existence of masses smaller than atoms was thus experimentally demonstrated, and a discovery was clinched of epoch-making importance.

### ELECTRIC THEORY OF MATTER.

### ESTIMATE OF SIZE OF ELECTRONS.

On the hypothesis that the flying or vibrating fragment is a material corpuscle charged with electricity, so that it has a duplex constitution and a compound kind of inertia, part material and part electrical, no further progress can be made. But on the hypothesis that the flying or vibrating particle is an electron—a charge of electricity and nothing else—a constituent of an atom, but with no material nucleus—so that the whole of atomic properties are to be considered as due to an aggregate of electrons of opposite size, of which one or two are comparatively free and detachable—on this hypothesis a determination of the mass of a corpuscle carries with it as a consequence a determination of its size also.

Because, as has already been pointed out, any required amount of self-induction can be conferred on a wire by making it fine enough, and any required amount of energy can be conferred upon an electric charge by making it concentrated enough. The energy at a given speed of motion will be proportional both to the quantity and the potential, and the latter can be made as great as we please by taking the size of the body possessing the charge extremely small.

It is the intense region of force close to the wire or close to the charged particle which is the effective region; and so, as stated, a knowledge of the mass or kinetic energy at a given speed suffices, on a purely electrical theory of matter, to determine the size of the electron constituents of which it is composed. For whether there be any intrinsically material inertia or not, there certainly is an electrical inertia. The cause of it in the electrical case is known: it is due to the reaction of the electric and magnetic fields during acceleration periods, and is denominated self-induction.

Quite possibly there is no other kind. Quite possibly that which we observe as the inertia of ordinary matter is simply the electrostatic inertia or self-induction of an immense number of ionic charges or electric atoms or electrons.

This is by far the most interesting hypothesis, because it enables us to progress, and is definite. The admixture of properties—partly explained, *viz.*, the electrical; partly unexplained, *viz.*, the material—lands us nowhere, unless by some only partially imagined means we were able to estimate how much of the corpuscle appertains to each ingredient.

The mass of a corpuscle has been measured at something akin to one one-thousandth of an atom of hydrogen, and its charge as $10^{-10}$ electrostatic unit. This amount of electricity will have that amount of inertia if it exists over a sphere of radius $10^{-13}$ centimetre, but not otherwise. Consequently, we may assume the size of the electron to be of the order $10^{-13}$ centimetre in diameter; or one one-hundred-thousandth of the linear dimension known as molecular magnitude —*viz.*, $10^{-8}$ centimetre.

In an atom of hydrogen there are roughly 1,000, or say more exactly, 700 electrons, in order to make up the proper mass. In an atom of mercury there must be over 100,000 electrons.

Consider then an atom of mercury containing 100,000 of these bodies packed in a sphere $10^{-8}$ centimetre in diameter. The whole volume of the atom is $10^{-24}$ c.c., the aggregate volume of all the electrons composing the atom is $10^5 \times 10^{-39} = 10^{-34}$ c.c., consequently the space left empty is $10^{10}$ or 10,000,000,000 times the filled space. Even inside an atom of mercury, therefore, the amount of crowding is fairly analogous to that of the planets in the solar system.

$$\frac{\frac{4}{3}\pi \times \left(10^{-8}\right)^3}{100{,}000 \times \frac{4}{3}\pi \left(10^{-13}\right)^3} = \frac{10^{-24}}{10^5 \times 10^{-39}} = 10^{10}.$$

From Loschmidt's theorem in the kinetic theorem of gases it is found that the mean free path of an electron inside an atom of mercury will be comparable to $10^9$ times the size of an electron, *i. e.*, it will be $10^{-4}$ centimetre—that is, it may get through on the average the substance

[1] *Phil Mag.* December, 1898, December, 1899.

of some 10,000 mercury atoms in a row without collision. The actual distance thus traveled by corpuscles plunging into a dense metal is very small, only the thousandth part of a millimetre on the average, and it need by no means necessarily be a straight line; so a target of platinum succeeds in stopping them fairly near its surface, and enables the X-rays generated by the shock fairly to emerge.

The colliding masses are 100,000 to 1, so the change of velocity at impact could be estimated; but the impact will really be more of an astronomical or cometary character, and the effect is analogous to the entrapping of comets when they pass near a planet, thereby rendering them permanent members of the solar system.

The stoppage, therefore, will occur well within the limits of atomic magnitude, $10^{-8}$ centimetre, and so the acceleration will be of the order $\frac{u^2}{2l} = 10^{26}$ c. g. s., and the force needed thus to stop even a single electron will be the tenth of a dyne. The "power" required to stop an electron, flying with one-thirtieth of the speed of light inside a molecular thickness, is estimated as equivalent to ten watts. (Though the time it lasts is only the $10^{-17}$ part of a second.)

JUSTIFICATION FOR ELECTRIC VIEW OF MATTER.

But now what justification is there for the extraordinarily far-reaching hypothesis that the electrons constitute matter, that atoms of matter are composed of electric charges, that the fundamental inertia-property of matter is identical with self-induction?

There is the reasonable philosophical objection to postulating two methods of explaining one thing. If inertia can be explained electrically, from the phenomena of charges in motion, it seems needless to require another distinct cause for it also. But this is not all that can be said; it is quite possible that direct experimental proof will be forthcoming before long. We know that when an electric charge moves with a speed approaching that of light, its inertia is theoretically no longer constant, but rapidly increases and becomes infinite when the light velocity itself is reached, at least on the orthodox and accepted theory.

It is possible that in certain cases of the production of cathode rays a speed not far short of that of light may be reached, and the increased inertia observed. Such an experimental determination has been seriously and quite recently undertaken by Professor Kaufmann,[1] who compared simultaneously the electric and the magnetic deflection of the same set of rays submitted alternately or simultaneously to an electric and a magnetic field. Thus the velocity and the $e/m$ ratio are both known, and Kaufmann concluded that when the speeds approached perceptibly near the velocity of light the electrochemical equivalent $m/e$ increased by just the amount required in accordance with pure electric theory—the theory which attributes the whole of inertia to electric influence. There appeared to be no quantitative room for any extra inertia, such as that of an inert particle of non-electric matter traveling with each projectile, retaining its inertia constant at all speeds, and so contributing nothing to the rise of inertia perceived when the speed approaches within hail of that of light.

Meanwhile the hypothesis is in itself so probable that it is justifiable to attempt to look ahead and observe some of the consequences of the view that all atoms of matter are built up of the same fundamental units, and are composed of aggregates of a definite number of variously grouped negative and positive electrons, arranged in kinetic patterns and keeping apart by reason of the vigor of their own orbital motions.

At first it is not easy to do more than imagine the electrons to be statically grouped together into regular patterns—arranged, it may be, in triangular or square or hexagonal order, with other allied three-dimensional possibilities familiar to students of crystallography.

ON CHEMICAL AND MOLECULAR FORCES.

The force of chemical affinity has long been known to be electrical. Ordinary electrical attraction between charged bodies may be called molar chemical action, only there is no combination in ordinary cases, because the opposing charges spark into one another, and so the attraction ceases when a certain proximity is reached. The idea that chemical forces are really electrical is as old as Sir Humphrey Davy.

Real chemical attraction occurs between two atoms, each of which contains an odd number of electrons—one extra, or it may be more than one extra, electron of given sign. Such an atom has a centre of force whereby it can attach itself to other atoms and enter into pairing or chemical combination with them. It is probable that a negative charge is an excess, and a positive charge a defect; and that when pairing occurs the excess charge of one fills up the deficiency of the other, and composes a complete and neutral molecule.

Union of this kind, however, never seems quite as strong and permanent as the union of the electrons in the atom itself; the molecule easily separates at the same place again under the influence of decomposing influences, and does not seem able to split up in other ways into new substances, except in organic chemistry, where various modes of splitting up a complex molecule can be brought about, and are practically utilized for the generation of new compounds.

It is probable that the same sort of thing is possible with simple bodies, but that the so-called "elements" constitute a peculiarly stable group, the ingredients of which so far have only partially been reassociated into isomeric or allotropic forms, and have not yet been detached from each other.

It is possible to charge an assemblage of neutral molecules with an excess or with a defect of one or more electrons by processes of ordinary electrification, but the attachment of these supernumerary electrons is loose, and they can be shaken away by the agitation of ultra-violet light and in many other ways. Even splashing of liquids into spray shakes some loose.[1] And in the case of massive molecules, their mutual collision or agitation under the influence of ordinary temperature is sufficient to shake away some of the loose electrons, which then fly off tangentially with whatever orbital velocity they may have had, giving rise to phenomena recently discovered under the name of radio-activity.

MOLECULAR FORCES—COHESION.

But there is another kind of adhesion of molecules, not chemical, but what is called molecular. This occurs between atoms not possessing ionic or extra charges, but each quite neutral, consisting of paired-off groups of electrons. At any moderate distance the force of attraction between paired electrons will be next to nothing, but at very minute distances it may be very great, ranging up to something almost indistinguishable from chemical combination, except that the cling will be a weak cling at a multitude of points instead of an intense cling at only one.

Consider the outer surface of an atom consisting of a regular group of interleaved electrons of alternately opposite sign. Its equipotential surfaces will be

[1] See *Comptes Rendus* for October 13, 1902.

[1] Lenard on electrification near waterfalls.

dimpled or corrugated or pimply sheets, which at a little distance away will be almost plain, the dimples increasing rapidly in depth and becoming like the cover of a mattress when something less than molecular distance, something approaching the internal electron distances apart is reached.

Two such atoms will therefore tend to settle down with their equipotential surfaces adjusted into uniformity, the dimples of the one fitting into the hollows of the other; and this is the state of things suggested by the facts of cohesion.

Molecular forces on this view are electrical, just as much electrical as are chemical forces; but they occur between chemically saturated molecules, and are due to the interaction or distant influence of paired electrons on each other across molecular distances.

Ions can not thus combine, because if they were oppositely charged their combination would be chemical, and if they were similarly charged they would strongly repel each other.

But if ions arrive at a metallic electrode, or are provided with other means of passing on their free charges, they cease to be ions and then they can and do combine molecularly with each other.

It is of course possible for an ion to have more than one free electron, forming a dyad or a triad radical; and the way in which a neutral group can receive and by rapid readjustment pass on an extra foreign electron, reminding one of the readjustment of the films in a lather when one compartment bursts, is doubtless instructive.

The effect of electric polarization on such a neutral group of electrons is noteworthy. The effect of a charged body in the neighborhood is at once to disturb the equilibrium and to disturb the grouping throughout the atom more or less; it will cause the negative electrons to protrude slightly on one side and the positive on the other.

If two molecules were beyond each other's molecular range, and if the neighboring surfaces could by any means, by the supply of electricity from without, be oppositely electrified, the forces of cohesion would be intensified momentarily by something akin to chemical forces, and cohesion would set in over ultra-molecular distances. This appears to be what goes on in a "coherer." The opposite charges can not be maintained electrostatically between two neighboring metallic surfaces, but they can be imparted with a sudden jerk or disruptive discharge or received electric impulse; and these are the things which are effective in promoting cohesion.

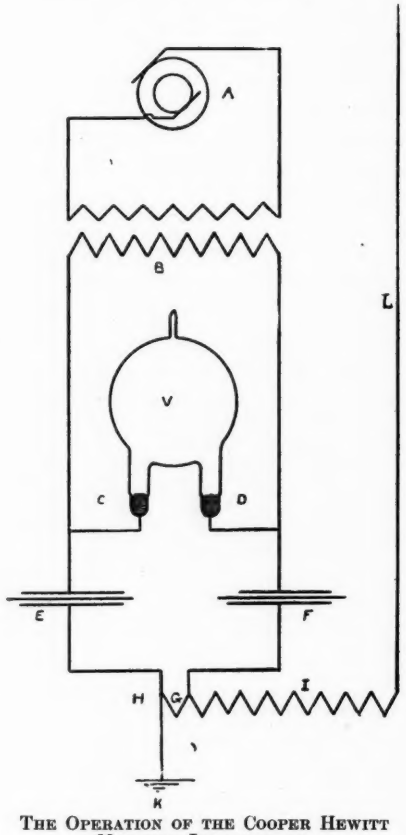
# *The Cooper Hewitt Mercury Vapor Current Interrupter.*

FOLLOWING close upon the exhibition of the Cooper Hewitt vapor converter by Mr. George Westinghouse, in England, Mr. Peter Cooper Hewitt announces another remarkable application of the mercury vapor lamp, based on its action as a current interrupter or breaker of marked effectiveness and very high frequency.

The action of the device depends on the peculiar behavior of the negative electrode resistance of the mercury vapor lamp. This resistance opposes the flow of current through the device until the difference of potential between the electrodes of the lamp has reached a certain high limit, when the initial cathode resistance collapses, and the current passes with but little opposition; so that, although a difference of potential of several thousand volts is necessary to break through the initial cathode resistance, a few volts only, even as few as fourteen, will maintain the current after the collapse. When, however, the current is stopped, or the difference of potential between the terminals falls below a certain small value, the initial high value of the cathode resistance reestablishes itself instantaneously. The potential at which the initial high cathode resistance collapses may be regulated in various ways, and varies from 2,000 volts or less up to almost any desired value, depending upon the size, shape and temperature of the tube and other features.

The vacuum tube interrupter can take the place of the usual spark-gap for discharging condensers, for which purpose it supplies the needed and long sought for low-resistance interrupter.

Reference to Fig. 1 will explain more




THE OPERATION OF THE COOPER HEWITT MERCURY INTERRUPTER.

clearly the operation of the device as a current interrupter. In the diagram, A is an alternator of ordinary frequency and low potential, B is a transformer which raises the potential to something like 10,000 volts, V is a Cooper Hewitt mercury vacuum tube, its mercury electrodes being C and D. Connected parallel to the tube are the condensers, E and F, which are connected in series by a turn of wire, G. This turn, G, is the primary of a step-up coil, and the coil, I, consisting of 25 or 50 turns of wire, is the secondary. The turn, G, is grounded at H, and the secondary coil, I, is connected to a conductor, say an upright wire, such as is employed in wireless telegraphy.

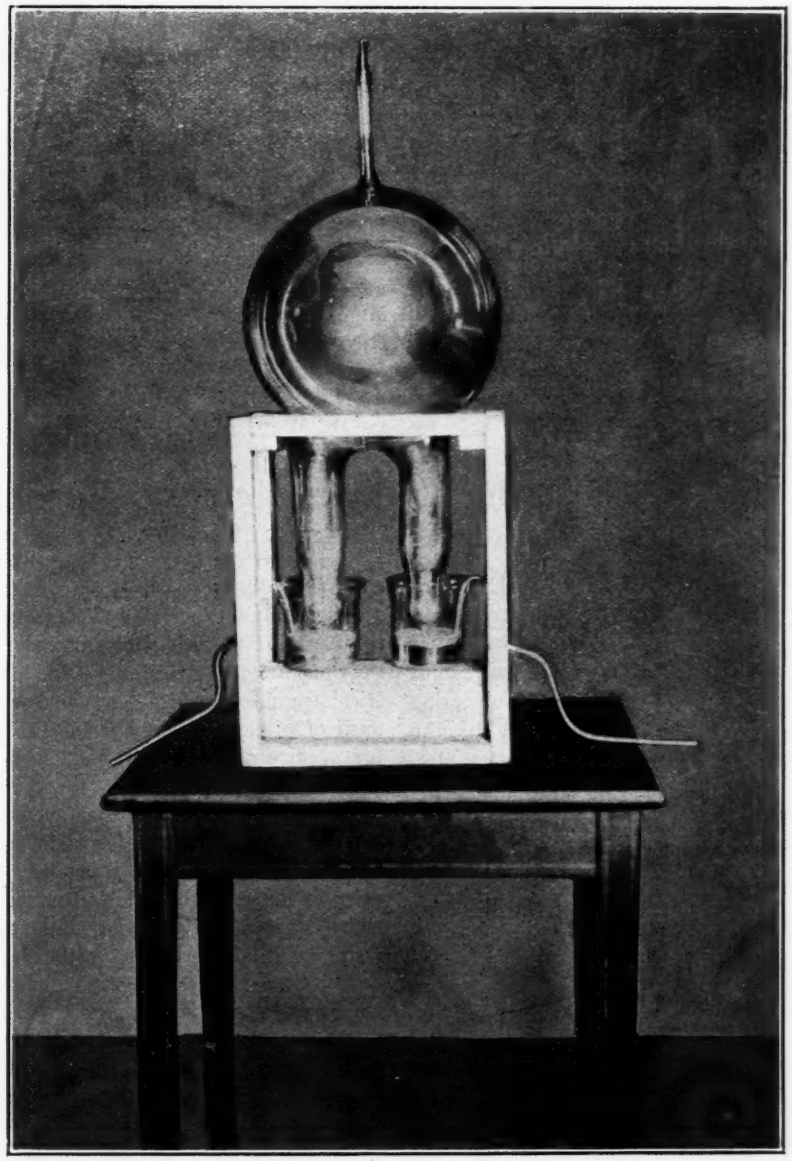
To understand the operation of the arrangement, consider what will take place as the alternating-current voltage supplied by the transformer, B, rises from zero to a maximum, and falls to zero again during one-half of its period. As long as its value is below the critical point at which the negative electrode resistance of the tube, V, collapses, the condensers, E and F, will be charged, but there will be no current passing through the tube. As soon as the voltage supplied by B reaches a value at which the negative electrode resistance of V collapses, then a sudden discharge of the condensers, E and F, will take place through the tube, the rapidity of this discharge depending on the inductance of the turn of wire, G, and the capacity of the condensers, E and F. It is an oscillating discharge, of course, but it differs from the oscillating discharge of an ordinary spark-gap in this respect: As soon as the first half oscillation is nearly

completed and the current has approached its zero value, the initial cathode resistance in the tube reasserts itself, and the next discharge does not take place until the condensers are charged to the full voltage again. In this manner we obtain a succession of rapid current impulses, separated from each other by small time intervals, these time intervals depending upon how fast the transformer, B, can recharge the condensers after each disruptive discharge through the tube. It is evident that with a sufficiently high power in the generating machine, A, and in the transformer, B, these current impulses can be made to follow each other with an exceedingly high degree of rapidity, say several millions per second. In that case the tube will be equivalent to a spark-gap operating with several million impulsive sparks per second. Such a spark-gap, of course, does not exist, and it seems that it can not exist, because a spark-gap operated even with as few as 100 sparks per second deteriorates very rapidly through disintegration and fails to operate with a sufficiently high degree of disruptiveness. In the mercury vapor tube, however, there is nothing to deteriorate.

Many attempts have been made to produce an effective high-speed interrupter which would have a reasonable life. Up to this time the discharge-gap between polished metal spheres has been most satisfactory, but it is far from perfect. In the first place, a spark-gap operating in air is too slow, owing to its resistance and to the character of the discharge across it. The effectiveness of the spark-gap in air is increased by using large metal spheres having polished surfaces, but the surfaces of these are rapidly destroyed by the current. That they are inefficient is proved by the rapidity with which they become heated if the discharge is of any considerable magnitude. The Cooper-Hewitt mercury vapor interrupter, on the other hand, seems to be free from all these defects. When a certain difference of potential between the terminals of the interrupter has been reached, the initial negative electrode resistance practically disappears, and the rapidity with which the discharge can take place depends only upon the capacity and the inductance of the circuit. In other words, the condenser charges and discharges at a definite frequency, determined by the circuit, and the source of supply. Discharges that will reenforce the oscillations before their decay are far more effective in producing the desired electrical effects in a suitable circuit than the irregular discharges of an ordinary spark-gap.

The efficiency of the mercury vapor interrupter is remarkably high. The difference of potential between its terminals during discharge is constant at about fourteen volts, and independent of the current. Thus, assuming the charging potential to be 14,000 volts, this loss of energy is used in vaporizing the mercury, which, coming in contact with the cool walls of the tube, condenses and runs back into the electrode receptacles, and thus furnishes a simple means of dissipating the heat generated within. To keep the apparatus cool, an oil-jacket or other suitable arrangement may be used. Since mercury is a liquid, and after being vaporized returns to this form, it will be seen that there is no deterioration in the breaker except that which may be occasioned by the walls of the containing-vessel.

In action, the interrupter is noiseless.



THE COOPER HEWITT MERCURY INTERRUPTER.

A typical form of interrupter is represented in the illustration. This consists of a glass globe eight to ten inches in diameter, with two closed tubes sealed into the lower hemisphere. These tubes are both partially filled with mercury, and into them are led the conducting wires. The globe is exhausted and sealed

off through a small glass tube attached to the upper point. To illustrate the effectiveness of the new device, at a recent exhibition in his laboratory in New York, Mr. Hewitt connected up a circuit similar to that already shown. A small alternator was driven by a two-horse-power motor. Closing the generator switch and then bringing the machine up to voltage, at a certain point—about 14,000 volts—the interrupter began to operate, and the effect was at once made apparent at the terminal of the antenna by violent current streamers. The effect could be changed in intensity by varying the excitation of the small generator. To show the difference between the action of the interrupter and a discharge through air, a spark-gap was connected in parallel with the former. By starting with the spark-gap terminals in close proximity and drawing them apart very carefully, the condensers, discharging through the gap, produced the usual current streamers at the antenna terminal. These increased as the electrodes were drawn apart until a certain point was reached, when the slightest further increase of distance between the electrodes caused the mercury vapor interrupter to substitute itself for the spark-gap, and at once the effect was shown at the antenna. The discharge there increased in violence many times, indicating a great increase in the quantity of discharge brought about by the use of the interrupter. In this experiment the capacity of each condenser was about 0.015 microfarad, and the diameter of the outer turn of the coil was thirty-eight inches; yet with the interrupter in operation, two horse-power could be radiated from the antenna. That the current flowing in the condensers was heavy was shown by the fact that although the wires leading to them were large, they became warm, yet there was only a slight heating of the interrupter. The interrupter has been run up to a calculated frequency of more than 1,000,000 discharges per second.

By reducing the inductance and the capacity of the circuit so as to increase the frequency, and by supplying the necessary power for charging, the energy which can thus be radiated may be anything desired. We have been told that it will be possible to pass 100 horse-power or more through a condenser composed of two quarter dollars separated by a sheet of glass. What the frequency would be under these conditions was not stated, although it is certain that if it was expressed in figures they would convey but a slight impression to the mind.

Extended researches with the mercury vapor tube are being carried on by Mr. Hewitt, and important developments are likely soon to be made public, to which we are not privileged to refer at this time.

## *Dr. Michael I. Pupin's Estimate of the Importance of the Cooper Hewitt Mercury Vapor Interrupter.*

DR. MICHAEL I. PUPIN, professor of electromechanics at Columbia University, and well known as the inventor of the Pupin system of long-distance and submarine telephony, is much interested in the Cooper Hewitt mercury vapor interrupter, and made the following statement of his estimate of the value of the new device.

He said: "I have watched the development of the Cooper Hewitt mercury vapor tube as an interrupter from the very beginning. The present operation of the device comes up to my highest expectations, and in my opinion it is one of the most important discoveries in physics which has been made during the last ten years. The operation of the tube as an interrupter depends upon two new elements in the character of the cathode resistance of the vacuum tube—first, the disappearance of this cathode resistance as soon as the impressed voltage has reached a certain value; second, its sudden reappearance as soon as the current strength through the tube has fallen below a certain small value. These two elements are entirely new, and they form one of the prettiest discoveries which Mr. Hewitt has made in the course of his investigations.

"I do not know of any other case where a physical discovery found such a rapid practical application, and this is due to the fact that physicists experimenting in the domain of electrical waves, and electrical engineers engaged in the development of wireless telegraphy, were waiting for a current interrupter possessing the very characteristics which the Cooper Hewitt tube possesses in consequence of the two novel elements referred to above.

"To illustrate this it is sufficient to refer to the needs of wireless telegraphy which the mercury vapor interrupter seems to satisfy. It is perfectly evident to-day that wireless telegraphy will not make any essential progress until a method is discovered of generating very powerful and persistent electrical waves. They must be powerful in order to overcome distance, and they must be persistent to enable us to employ the methods of selective tuning. The Cooper Hewitt mercury interrupter is capable of furnishing just such kind of electrical waves, and there is no other interrupter which comes anywhere near it in this respect. I do not think that I am saying too much when I state that the contribution which this development will make to wireless telegraphy is by far the most important which has been made since Marconi's earliest experiments, which demonstrated the practicability of transmitting electrical energy without wires to a distance of over twenty miles by employing two upright wires, each grounded, and impressing on the sending wire electrical oscillations such as Hertz employed in his classical experiments.

"The early experiments by Mr. Marconi were a revelation to physicists, not because they contained any physical novelty, but because they demonstrated that by a certain arrangement of receiving and transmitting conductors the waves generated could be felt at such a long distance. I think it will be admitted on all sides that since the time of Marconi's early experiments, no new knowledge with regard to the method of generation or transmission of the electrical waves has been offered to those who are engaged in the practical development of wireless telegraphy, so that to-day wireless telegraphy is practically in the same condition in which it is was in 1896. The Cooper Hewitt mercury vapor interrupter is the first contribution which possesses extraordinary novelty, and which on account of its peculiar properties is the very thing needed in order to extend wireless telegraphy with a single stroke away beyond its present limits. How far this extension will reach I am not prepared to say, but that it will be far-reaching there is not the slightest doubt in my mind."

# *Independent Telephone Association of Wisconsin.*

*Proceedings of the Convention of the Independent Telephone Association of Wisconsin, Held at Milwaukee, on February 11 and 12, 1903.*

THE opening session was called to order at the Convention Hall of the Hotel Pfister at twelve o'clock, noon, on Wednesday, February 11. President Richard Valentine read his annual address, in which he spoke of the continued rapid growth of the independent telephone business in the state. Many companies had increased their capital stock, and during the year forty-one new telephone companies, with a total capital of over $1,000,000, were organized, and the present number of independent companies in Wisconsin was 200, having 1,000 toll stations, 200 exchanges and 30,000 subscribers. In most of the cities still remaining under monopoly rule, exchanges were being built or contemplated. Great progress was also being made in developing the rural telephone business. Long-distance copper trunk lines were needed more than ever, to connect the many local systems, but there was the strongest assurance that these would be built the coming season. He also spoke of the final decision of the Berliner patent suit.

On motion that a committee on resolutions be appointed, the chair selected Messrs. Crowley, Teasdale and Goodrich.

On motion that a committee be appointed to consider the advisability of publishing an association organ, the chair appointed Messrs. Harper, Dinsmore, Schernecker, Munsell, Abbott, Lloyd and Winter.

A committee of five on legislation was appointed, consisting of Messrs. Harper, Hutchinson, Ferdinand, Larson, Valentine and Cavanaugh.

Motion was made and adopted that a committee of five be appointed to consider and revise the schedule of toll rates, and the chair appointed Messrs. Hutchinson, M. D. Larson, Harper and Teasdale.

A committee of five was appointed to draft suitable memorial resolutions upon the death of Mr. Lohmiller and Mr. Collonious, members of the association. The committee appointed was Messrs. Keelyn, Bell and Kepler.

The meeting then adjourned, reconvening at 2.30 P. M.

Mr. Keelyn presented the report of the memorial committee upon the death of Mr. Lohmiller, of the La Crosse Telephone Company, a member of the executive committee, and Mr. Collonious, of the Central Wisconsin Telephone Company, of Portage, and the same was adopted.

Mr. A. L. Hutchinson, of Weyauwega, of the Interurban Telephone Company, then read a paper on "Uniformity of Toll Rates."

Mr. C. W. Farr, of Chicago, of the Farr Telephone and Construction Supply Company, made an address on the subject of "Generators," discussing at length the many requirements of a proper telephone generator.

Mr. J. E. Keelyn, of the Western Telephone Manufacturing Company, Chicago, gave a talk on "New and Old Telephone Problems." He discussed briefly the early history of the telephone, and talked of the rapid progress made by the independents.

On motion, a committee was appointed to devise plans for interesting the citizens of Milwaukee and securing an independent telephone exchange in that city. This committee consists of Messrs. Cavanaugh, Lloyd, Ferdinand, Baer and Keelyn.

Mr. J. C. Harper, Madison, of the Dane County Telephone Company, talked on the subject of "Prospective Telephone Legislation," in which he referred to bills so far introduced in the legislature and discussed the effect they would have on the independent telephone business. He advised against the bill compelling interconnection between different telephone companies, as this would be to the disadvantage of the independents.

Mr. Valentine discussed such a bill, and gave many reasons against the passage of such a measure.

The meeting was then adjourned to 10 A. M. the next day.

THURSDAY SESSION.

Mr. W. A. Taylor, of the Standard Telephone and Electric Company, Madison, read a paper on the "Comparative Merits of the Magneto and Central Energy Systems."

Mr. Dinsmore presented the report of the committee on an association publication, in which the committee advised against such a publication and asked the convention to consider the selection of one of the many telephone organs now being published as the official publication of the association, and, on motion, the report was adopted.

Mr. A. L. Hutchinson presented the report of the committee on toll rates, and the report was discussed at length by Messrs. Valentine, M. D. Larson, Thielman, A. W. Larson, Crowley, Hutchinson, Bell, Lloyd, Hackney, Nate, Fehland, Croll, Slater, Bryant and Middlesworth and Mansfield, which brought out a great variety of opinions on this subject, and, after some amendment, the report was adopted.

A new resolution was also adopted on this subject, that to encourage the investment of capital to build long-distance copper toll lines, the companies of the association would be willing to handle such long-distance business for a commission not to exceed fifteen per cent of the outgoing tolls. Mr. Crowley suggested that all the companies in the independent association take a proportionate share in the long-distance company, to the amount of ten per cent of their own investment, and in this way the long-distance lines would soon be built.

Then followed a discussion of the toll rates and lines, after which the meeting was adjourned, reconvening at 2.15 P. M., when Mr. Harper presented the report of the committee on legislation to the effect that the legislative bill giving telephone companies the right to the indiscriminate trimming of trees be opposed, as this would arouse public sentiment, and that the bill to regulate the telephone and toll rates be also opposed, unless the same could be modified.

The committee further recommended that a bill be introduced in the legislature to prohibit discrimination in telephone charges in cities belonging to the same class, and for this purpose the citizens of the state be divided into a certain number of classes. Such report was adopted, and on motion the legislative committee was made permanent.

On motion a committee of three was appointed to nominate officers, consisting of Messrs. Bell, Hackney and Goeselin.

Mr. Hackney read an extract on rural telephones from a magazine, and as this article advised the construction of cheap rural lines it was criticised by Mr. Hackney and others in the convention.

Mr. Crowley presented the report of the committee on resolutions, in which the press of Milwaukee was thanked for its efforts to inform the citizens of Milwaukee of the growth and importance of the independent telephone business of Wisconsin. And further, that this association request its members not to patronize supply companies to other independ-

ent companies, attempting to undermine independent companies now established. Further, that only such companies that connect their toll lines and exchanges with other legitimate independent companies, where opportunity offered, shall be eligible to membership in this association. And further, that thanks be extended to the officers and committees of the association for their faithful service the past year, and that in future meetings all supply companies close their exhibits during the hours that the convention is in session. This report was discussed, and after a slight amendment was adopted.

Attention was also called to the fact that where any independent company was buying its supplies from certain companies it was patronizing the Bell company, and it was the sense of the meeting that no independent company should continue assisting in this way.

The secretary then read the following list of companies that has made application for membership, and on motion each application was accepted. The Sheboygan Telephone Company, Sheboygan; the Northwestern Telephone and Electric Company, Milwaukee; Mt. Horeb Independent Telephone Company, Mt. Horeb; Valley Telephone and Telegraph Company, Green Bay; McFarland Telephone Company, McFarland; Citizens' Telephone and Electric Company, Kenosha; Menominee Range Telephone Company, Iron Range, Mich.; Maquon Telephone Company, Thienville; Rock River Valley Telephone Company, Lake Mills; Wausaukee Telephone Company, Wausaukee; Mazomanie Telephone Company, Mazomanie, and the American Electric Fuse Company, Chicago; Automatic Electric Company, Chicago; Illinois Electric Specialty Company, Chicago; Swedish-American Telephone Company, Chicago; Holtzer-Cabot Electric Company, Chicago; Green Telephone and Electric Manufacturing Company, Milwaukee.

The secretary then read his annual report for the past year, showing the financial condition of the association.

On motion an assessment of one cent per telephone and two cents per mile of toll line was levied upon the members.

Mr. Hackney then presented the report of the committee on nominations as follows:

President, Richard Valentine, Janesville.

Vice-president, H. G. Slater, Waupace.

Secretary-treasurer, H. C. Winter, Madison.

Members of the executive committee: C. W. Twining, Monroe; F. H. Sweet, Fond du Lac; J. C. Harper, Madison; W. F. Goodrich, La Crosse; J. Thielman, Merrill; John M. Baer, Appleton; M. F. Smith, Hixton; J. C. Crowley, Jr., West Superior, and William J. Bell, Baraboo, committeemen at large. On motion this report was adopted.

Mr. Valentine thanked the association for the honor again bestowed upon him. He predicted that this present year would see the construction of the much-needed copper toll lines; that all should cooperate in this work.

On motion it was decided to hold the June meeting at Madison, and the next annual meeting again in the city of Milwaukee.

Mr. Harper then spoke of the telephone situation in Madison, and what new methods were employed by the Bell company in attempting to secure a foothold in that city.

On motion that a committee of two be appointed to devise a design for advertising independent telephone stations, the chair appointed Mr. Birch and Mr. Ritter and requested them to report at the June meeting.

On motion the convention adjourned *sine die*.

## *Meeting of the Pittsburg Local Branch of the American Institute of Electrical Engineers.*

The Pittsburg local branch of the American Institute of Electrical Engineers held its monthly meeting at the Electric Club, Thursday, February 5, to consider the papers on telephony recently read in New York. President Scott's introduction was read by Secretary J. S. Peck. "The Evolution of the Telephone Switchboard," by Mr. Thomas D. Lockwood, was abstracted by Mr. P. P. Grace. Professor S. M. Kintner abstracted the paper on "An Automatic Telephone Operator," by Mr. W. J. Hammer. These were followed by a paper entitled "The Archophone," by Mr. R. A. L. Snyder, which gave a brief history of the archophone, or speaking arc, which was discovered by Dr. Simon, at the University of Erlangen, in the fall of 1897. Since that time, Dudell and Ruhmer have studied the subject and added materially to the results. Dudell shunted the arc with inductance and capacity, and thereby produced the whistling arc. Ruhmer employed a telephone receiver and battery, placed in series with a selenium cell at the receiving station. A searchlight was used for transmitting. Attempts to use an alternating arc gave reasonably good results, but there was a musical note superimposed upon the spoken sounds. Several theories have been advanced to explain this. The most logical gives as the cause the expansion and contraction of air due to variations in the temperature of the arc. It was thought that this apparatus might have an application enabling a single speaker to address large audiences but with little effort. A speaking arc was shown in operation at the meeting.

During the discussion, Mr. Charles Bradley called attention to the fact that only within the past ten or twelve years has the telephone work been developed from an engineering standpoint. He pointed out many decided improvements brought about in this way, all tending to reduce the work and simplify the work of installation and transfer as much as possible of the wiring to the factory. Thus the unicolored cable has been replaced by the multicolored cable, and the same jack takes the same colored wire throughout the installation. By constructing the framework of the switchboard of iron, more uniform sizes are secured, and, by careful measurements, cables can be cut and soldered to the jacks in the battery. In fact, the entire work of constructing an installation of telephone switchboard has been so classified that but few details are left to the installer.

Mr. Charles Bradley presented a paper discussing installations of switchboards and general systems of standardizing apparatus, and an original paper was presented by Mr. S. H. Browne. The discussion was further participated in by Mr. P. P. Grace, Mr. P. M. Lincoln, Mr. Gallegher and Mr. L. Hommel.

## *Philadelphia Branch of the American Institute of Electrical Engineers.*

A meeting of the Philadelphia Branch of the American Institute of Electrical Engineers will be held in Philadelphia on February 18, 1903. The organizers are Carl Hering, Charles Hewitt, H. A. Foster, J. F. Stevens, A. B. Stitzer, W. C. L. Eglin and H. F. Sanville.

## *Schenectady Branch of the American Institute of Electrical Engineers.*

The Schenectady Chapter of the American Institute of Electrical Engineers held a local meeting at Schenectady, N. Y., on January 25. Past-President Charles P. Steinmetz presided. R. N. Williams was appointed honorary secretary, and a local committee appointed as follows: W. I. Slichter, M. G. Reist, W. C. Ely, Jr.

### *The Next New York Meeting of the American Institute of Electrical Engineers.*

The 173d meeting of the American Institute of Electrical Engineers will be held at 12 West Thirty-first street, New York city, on February 27, 1903.

The subject of the meeting is "Railway Train Lighting," and the following papers will be presented:

"The Bliss System," by William L. Bliss.

"A New System of Train Lighting," by Elmer A. Sperry.

"The Consolidated Axle Light System," by Arthur J. Farnsworth.

### *Boston Branch of the American Institute of Electrical Engineers.*

The first joint meeting of the American Institute of Electrical Engineers and the Electrical Engineering Society of the Massachusetts Institute of Technology took place on Friday, February 13, at the Tech Union. There were nearly 200 in attendance, Messrs. G. A. Hamilton, Samuel Sheldon, Charles F. Scott, E. H. Mullin and Ralph W. Pope making the trip from New York. About a dozen members from Lynn, Mass., were in attendance.

Professor Elihu Thompson had charge of the meeting. He complimented the Tech society on its large attendance and its manifest interest in the founding of a branch society in Boston. He also spoke to some extent of the functions of the American Institute of Electrical Engineers, of the drawing together of engineers to make their work more efficient. He spoke of the great activity in electrical engineering circles, and the large problems that are facing the engineers of the present time.

Professor Thompson then introduced Charles F. Scott, president of the American Institute of Electrical Engineers. Mr. Scott gave a brief talk on what the society was doing. Mr. Ralph W. Pope, secretary of the American Institute of Eectrical Engineers, then gave an interesting talk on the formation of new chapters of the society. Dr. Samuel Sheldon, of the Polytechnic Institute of Brooklyn, gave a brief talk on the growth of the society.

The speaker of the evening was Mr. Thomas D. Lockwood, consulting engineer of the American Telephone and Telegraph Company, who read a paper on "The Evolution of the Telephone Switchboard."

Dr. Pritchett, of the Massachusetts Institute of Technology, gave a short address in which he welcomed the American Institute of Electrical Engineers and earnestly hoped for a speedy establishment of a chapter in Boston.

After the speeches luncheon was served and the meeting broke up after a thoroughly enjoyable evening.

A committee has been appointed to cooperate with the Electrical Engineering Society of the Massachusetts Institute of Technology.

### *The Louisiana Purchase Exposition.*

April 30, next, will be the one hundredth anniversary of the signing of the Louisiana treaty. The event will be celebrated by the dedication of the Louisiana Purchase Exposition's buildings and grounds, and by other exercises extending over three days. The dedication ceremony will be performed by Theodore Roosevelt, President of the United States. The principal address will be delivered by his only predecessor still living, ex-President Grover Cleveland. The presiding officer will be the Hon. David R. Francis, president of the exposition. He will tender the buildings and grounds to the Hon. Thomas H. Carter, president of the National Commission, who will then turn them over to the President of the United States. Three dignitaries of the church —Cardinal Gibbons and Bishop Hendrix and Bishop Potter—will officiate in the religious portion of the exercises, and the chorus will consist of 2,000 voices from the Choral Symphony Society, the Saengerfest Chorus, the Morning Choral Club, the Apollo Club and Mrs. James L. Blair's choral classes.

The exercises will be attended not only by President Roosevelt, but also by the members of his cabinet; the foreign ambassadors and ministers at Washington, D. C., and the entire diplomatic corps; by the chief justice and the associate justices of the United States Supreme Court; by the members of both branches of Congress; by a number of the highest officers of the American army and navy; by the governors of many states and territories, including those comprising the Louisiana Purchase; by the members of the World's Fair commissions of the different states and territories, and by many other persons of distinction. The dedication exercises will be held in the afternoon of April 30. In the forenoon there will be a military parade with Major-General Corbin as grand marshal. The procession will have several thousand soldiers from the regular army and a still larger number from the state troops.

It is expected that there will be fully 300,000 people on the grounds that day. In the evening a display of fireworks will be given, which promises to be grander than anything of the kind ever heretofore attempted. The second and third days of the celebration will be devoted to the reception of distinguished foreign guests, governors of states, state commissioners, etc. Another grand display of fireworks will be given on the evening of Friday, May 1, and on the afternoon of that day, as also on the following day, Saturday, May 2, there will be an exhibition of day fireworks.

### *Proposed Changes in Form of Science Abstracts.*

The publishers of *Science Abstracts* make the following announcement:

The review will in future be published in two sections; Section A—physics, embracing light, including photography, heat, sound, electricity and magnetism, chemical physics and electrochemistry, general physics, meteorology and terrestrial physics, physical astronomy.

Section B—Embracing steam plant, gas and oil engines, automobiles, oil-engine-driven ships and launches, balloons and airships; general electrical engineering, including industrial electrochemistry, electric generators, motors and transformers, electrical distribution, traction and lighting, telegraphy and telephony. The subscription prices will be eighteen shillings or $4.50 for each section separately, including index, for the two sections, thirty shillings, or $7.50.

The American Physical Society is now joined with the Institution of Electrical Engineers and the Physical Society of London in the direction of the publication and has elected Professor E. H. Hall, of Harvard University, as its representative on the publishing committee. In consequence of this arrangement, Section A will in future be received by all members of the American Physical Society. The American Institute of Electrical Engineers is also cooperating with the committee and taking special means to bring the publication to the notice of all its members, who will in future be able to obtain it at a reduced subscription rate through the secretary of the American Institute.

## INDUSTRIAL ELECTROCHEMISTRY AND ELECTROMETALLURGY—VI.

### *Notes on Progress in Europe and America.*

BY JOHN B. C. KERSHAW.

*Metallic Sodium as a Reducing Agent.*

Mr. James Swinburne in the presidental address delivered in December last before the members of the London Institution of Electrical Engineers, referred to the electrolytic methods of obtaining metallic sodium. After stating that he did not intend in this address to adopt the rôle of prophet, he in the usual manner lost sight of this self-imposed restriction, and predicted that in a few years this metal would be sold for a few pounds per ton, and that such a reduction in the price would revolutionize many chemical processes.

The chemical value of sodium lies in its great chemical affinity for oxygen and the halogens. There are few metals which can retain these elements in presence of sodium, and therefore cheap metallic sodium would place a remarkable effective reducing agent in the hands of the metallurgist. The original process used for manufacturing aluminum was, in fact, based on the reduction of aluminum chloride by metallic sodium. It would be a curious result should the cheapened production of the latter metal by electrolysis render this process for aluminum production again practicable, and enable it to compete with the electrometallurgical process which displaced it thirteen years ago.

At present metallic sodium is produced at several works in Germany, and at one each in France, England, and America, by the Castner process. In France, the Becker process is also in use at a second works at Bellegarde. These processes differ merely in details of cell construction; sodium hydrate is the raw material in each case. Darling has recently perfected a process in which sodium nitrate is used as electrolyte in place of the hydrate. The advantage in this case is that nitric acid is obtained, in addition to the metallic sodium, and thus two profitable products are obtained by the one electrolytic decomposition. Although the Darling process is more difficult to operate than the Castner process, it is possible that it may develop into a practical industrial process. If such development could occur, or if the electrolytic decomposition of fused sodium chloride and separation of the two constitutents in their elementary form should be proved practicable, the prophecy of Swinburne, referred to at the commencement of this note, may be realized in a comparatively short time.

At present, the sodium produced by the electrolytic methods is used most largely for the production of sodium peroxide and of sodium cyanide in the works named above, and only a small proportion of the output finds its way into commerce as metallic sodium.

Sodium at $24 per ton, or a little less than one cent per pound, would, however, command a much larger market, and its use as a reducing agent now confined to the organic chemical industry, as Swinburne has pointed out, would be widely extended.

*Nitric Acid and Nitrates from the Air.*

The industrial trial now proceeding at Niagara with the Bradley & Lovejoy process for converting the nitrogen of the air into nitric acid or nitrates by means of spark discharges of high-tension electricity, is a most interesting attempt to solve an old industrial problem, namely, the fixation and utilization of the nitrogen of the air. The formation of nitrogen oxides during thunder-storms has been known for years, and at a Royal Society soiree in 1892, Sir William Crookes exhibited the flame of burning nitrogen. In 1897 Lord Rayleigh read a paper before the Chemical Society, London, in which he gave details of laboratory experiments relating to the formation of nitric acid by high-tension discharges. In 1898 Sir William Crookes in his presidential address before the British Association at Bristol referred to these laboratory investigations, and showed that on the basis of Lord Rayleigh's figures, one ton of nitrate of soda could be produced with an expenditure of electrical power equal to 14,000 kilowatt-hours, and that at Niagara this power would not cost more than $24. This estimate of cost does not appear to be correct. The electrical horse-power-year equal to 8,760 electrical horse-power-hours costs at Niagara, $20; 14,000 kilowatt-hours would therefore cost over $40. McDougal & Howles experimenting in Manchester, in 1900, obtained however a greatly increased yield of nitric acid by electric discharges, when using in place of the air an artificial mixture of oxygen and nitrogen, represented by the ratio of two to one. I have not seen any reliable figures for the output and efficiency of the apparatus installed at the works of the Atmospheric Products Company at Niagara, but probably the yield of nitrogen oxides per kilowatt-hour is higher than that obtained either in Lord Rayleigh's or in McDougal & Howles's experiments. Details on the experimental plant were given in the ELECTRICAL REVIEW of October 18, 1902, and it was there stated that the percentage of nitrogen oxides in the air issuing from the apparatus is kept low (between two per cent and three per cent) in order to avoid losses by dissociation. It is possible that in this precaution, and in the mechanical details of the apparatus, which admits of 138 arcs being sprung and broken fifty times per second, may be found the improvements which have raised the method into the region of practical industrial processes. Should success be ultimately achieved, Messrs. Bradley & Lovejoy will deserve the congratulations of both electricians and chemists, and they will no doubt share in the financial rewards, which the production of nitrates from the air is likely to bring to the founders of this new industry.

*Electrolytic Antimony.*

The ordinary metallurgical process for the extraction of antimony from its ores is based upon the low melting point of the sulphuret, the form in which it usually occurs in minerals. The ore is heated until the sulphuret melts, and this is then run off and cast into cakes. The crude antimony obtained in this way is melted with iron, and the separation of the metallic antimony from the sulphide of iron is effected by ordinary mechanical and metallurgical methods.

As antimony can be electrolytically separated from solutions of the poly-sulphide without difficulty, it is natural that attempts should have been made to use electricity for the extraction of this metal from its ores. Siemens & Halske worked out the details of such a process some years ago, and this is now reported to be in use in Vienna and at Banya in Hungary. The Siemens & Halske process is based upon extraction of the pulverized ore with a solution of sodium hydro-sulphide, and the electrolysis of the resultant poly-sulphide solution of antimony and sodium in a diaphragm type of cell. In the original patent it was proposed that the anode-chamber of the cell should be charged with a sodium chloride solution, and that the chlorine liberated should be used to extract the remaining metals from the residue from the leaching vats. This part of the patent has, however, not proved practicable, according to Borchers.

At Cassagna, in France, another electrolytic process is said to be in operation, in this case, also, the poly-sulphide being used as electrolyte. The cell, which is of the diaphragm type, and the process have been described by Izart in the *Electricien* July 19, 1902. In this article Izart states that a current efficiency of seventy-six per cent can be obtained in the cell when using a current density of 0.80 ampere per square dcm. and electromotive force of 1.6 volts. In view of the simplicity of the ordinary metallurgical process for extracting antimony from its ores, and the limited market that exists for the metal, it is doubtful whether either of these electrolytic processes for its extraction will undergo industrial development.

# Wireless Telegraphy by the Fessenden System.

By A. Frederick Collins.

WORKERS in the field of wireless telegraphy have had for the object of their labors three well defined propositions, each of them infinitely difficult of solution and all immeasurably important in the whole scheme of commercial transmission of intelligence without wires.

These three factors are distance, syntonization and economy in operation. The question of sending cableless messages is far-reaching in its effects, not only in distance but in its ultimate modification of existing transoceanic intercommunication as well. Long-distance wireless telegraphy appeals more strongly to the majority of inventors than syntonization, where economy is not a consideration, since the laws governing the factors by which distance may be successfully overcome are quite clearly understood.

The relation between long-distance transmission and economy of operation is obvious and the problem of combining them in a system is a mighty one; in view of the fact that the propagation of electric wires to a distance of two thousand miles has been experimentally proven possible, the great desideratum now is to transmit a minimum of energy in the form of waves and to utilize the maximum value of the wire at the receiving device.

Professor Reginald Fessenden has been one of the few scientists who has devoted time and given thought to the economical working of wireless telegraphy, and by systematic investigation of this phase of the art, covering a long period, Fessenden has succeeded in perfecting a responsive device which fulfills all the conditions above cited and bids fair to render competition probable between land lines and wireless telegraphy, and aside from this he has been exceedingly diligent in bringing to light many new phenomena having a higher theoretical as well as a practical value and which will prove of incalculable service in improving the art.

In a recent communication to me, Professor Fessenden put forth some of the original features of his system, and before describing the apparatus invented and employed by him it will be of interest to sum up these agents since they will serve to show just what the inventor had in mind and his purpose in working along the lines indicated in the text of this article.

In the ordinary coherer the change of resistance is caused by the voltage, due to oscillations set up by the impinging electric waves; in the barretter, as Professor Fessenden terms his responsive de-

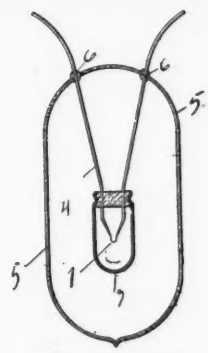



FIG. 1.—CURRENT-ACTUATED WAVE-RESPONSIVE DEVICE.

vice, the action is due to current instead of voltage. The barretter or current-operated electric-wave detector is superior to coherers for the following reasons:

(*a*) It permits of a much higher speed, sixty-five words per minute having been attained by skilled operators using a typewriter, while fifteen words per minute is the maximum speed of the ordinary coherer; (*b*) with coherers sharp electrical tuning is not possible; that is to say, where resonance effects are the result of voltage rather than current, there is a large percentage of loss, and hence selectivity can never be very pronounced. Again, atmospheric disturbances are usually caused by potential differences in coherers, and this is eliminated in the current-actuated barretter.

For this reason, too, Fessenden asserts that a coherer-actuated receiver can never should be employed in selectivity systems, while in the case of his current-operated barretter, absolute resonance may be had, which in practice has permitted a selectivity of one-half of one per cent. The economical features of his current-actuated wave receiver will be best understood when it is stated that the Fessenden detector is 25,000 times as sensitive as the best coherer, and that the barretter has been in operation for months over a distance of fifty miles with a spark only one-thirty-second of an inch long, using vertical wires at the transmitting and receiving ends of 140 feet high; whereas, in order to operate a coherer over the same distance with plain vertical wires a Ruhmkorff coil giving a maximum spark of five and one-half inches in length is required.

The current-operated receiver is absolutely positive in its action and "X's" or strays, as atmospheric and unknown sources of momentary potentials are called, can not be registered, and so effect a message, consequently code messages may be sent with absolute fidelity.

In syntonic wireless telegraph systems thus far evolved the fundamental principle of electrical resonance has been incorporated, and the cumulative effect of a series of feeble impulses which would finally break down the resistance of the coherer by the increase of voltage has been tried. The action of current-operated receivers may be made cumulative to any desired extent, *i. e.*, to depend upon the total amount of energy radiated instead of on the maximum amount; hence,

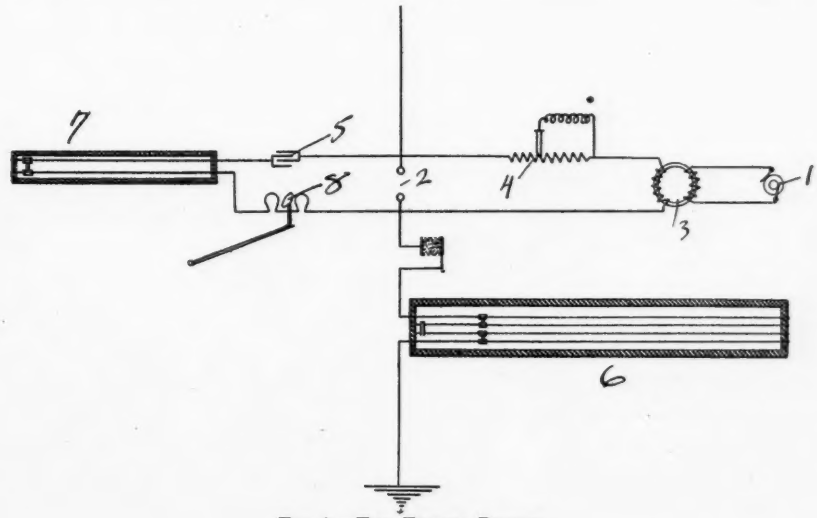



FIG. 2.—THE TUNING DEVICE.

low-potential and prolonged oscillations can be used instead of high-potential oscillations with equal effect, and all this effects the economy of long-distance transmission to a very large extent; for instance, much lower masts may be employed and Fessenden has telegraphed over a distance of 100 miles with a coil giving a quarter-inch spark and a simple vertical wire forty feet in height.

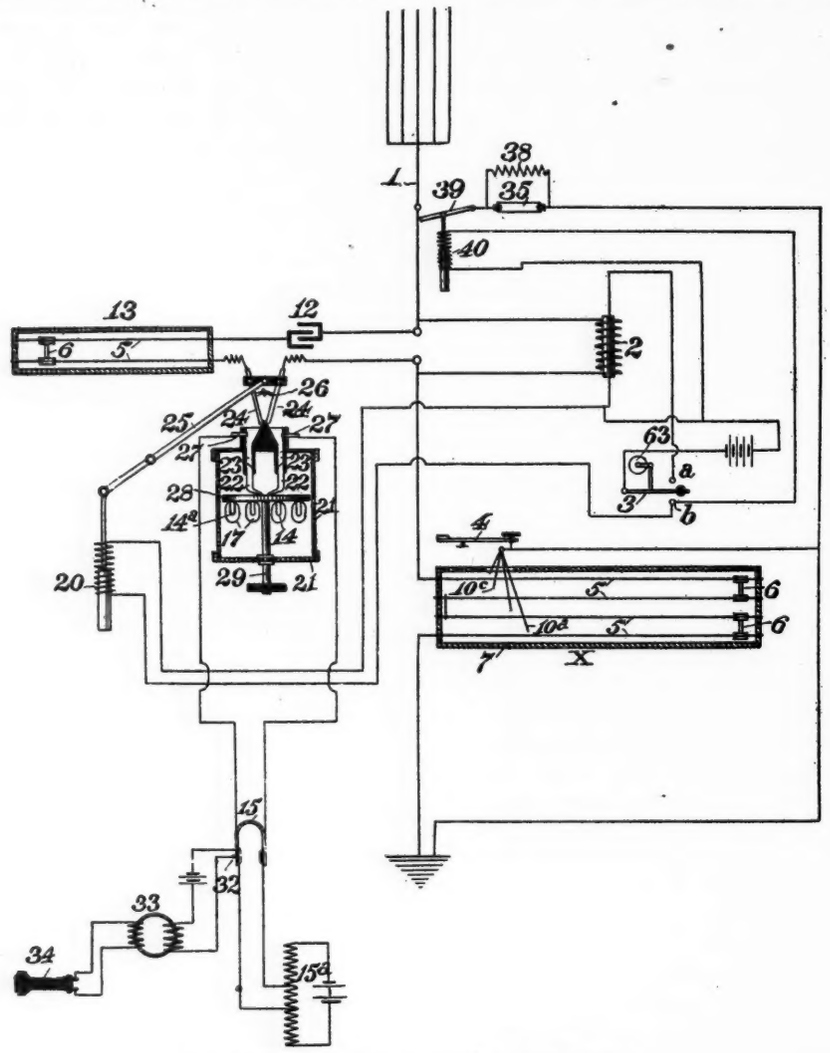



Fig. 3.—The Diagram of the System Complete.

Another original feature of the Fessenden system is employing an auxiliary circuit for prolonging oscillations. The first step toward tuning a circuit is due to Oliver J. Lodge, who made use of inductance coils; now the action of an inductance coil is to cut down the effect of radiation per oscillation; in the system under consideration a local circuit, to be described hereafter, is charged with a large amount of energy and supplies the vertical wire or antenna as fast as it is emitted and therefore much more powerful effects are obtained, which, according to Fessenden, is several hundred times as great. Another original point is the use of large capacities which are uniformly distributed, and the use of closed, tuned circuits at the receiving end. The wave-chute or artificial ground is, in my opinion, one of the best devices in this system, since it assists in eliminating external disturbances and in directing the electromagnetic waves in a given direction.

There are numerous other clever and original features, such as surrounding the radiating wire with a suitable medium for decreasing the length as now used, the use of a pressure bulb for increasing the radiation so that it will be proportional to the spark-length, etc. On all of the foregoing devices patents have been granted, and many other patents have been applied for but not yet granted.

For instance, Fessenden claims the broad, general method of working selectively by using different periodicities for each station, which was originally invented by him for the Pennsylvania Railroad Company in 1891.

The current-actuated wave responsive device, referred to above, was the subject of a patent granted August 12 to Professor Fessenden. It is shown in Fig. 1, and in the form used in practice it consists of a silver wire 0.1 inch in diameter, and having a platinum coil 0.003 inch in diameter, both the external silver and the internal platinum wires are then drawn down until the silver sheath is about 0.002 inch in diameter, and the platinum coil is 0.00006 inch in diameter.

These dimensions may be varied considerably, providing the low heat capacity is maintained; that is to say, the conditions must be such that the radiating surface is as small as possible, in contradistinction to the bolometer, which has a large radiating or absorbing surface in proportion to its mass; Fessenden therefore prefers a cylindrical form of conductor as having the least surface per given volume.

The theory involved is based on a new discovery; *i. e.*, that "if a conductor having a specific heat-factor of such value that the latent energy required to raise its temperature to a certain excess above the air is small relatively to the energy lost by radiation, convection and conduction at that excess temperature during the time of a signal, then it is possible to so arrange that conductor in a local continuous-current circuit, that when a given amount of current of any periodicity or wave-form is caused to flow through that

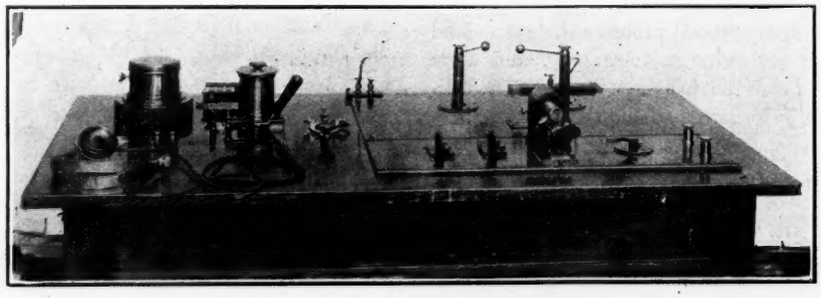


Fig. 4.—The Operating Apparatus.

conductor there will be a corresponding charge of the same magnitude in the activity of the local continuous-current circuit."

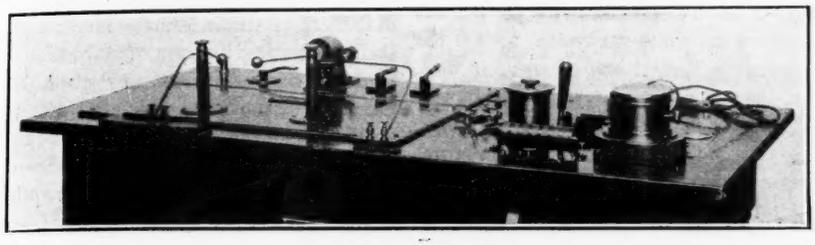


FIG. 5.—THE OPERATING APPARATUS.

This form of detector is entirely separate and distinct in the principle involved, and construction from the bolometer and Siemens resistance thermometer. Neither of these instruments will act efficiently as receivers, because their specific heat capacity is so large when compared to their conduction and radiation losses that only an infinitesimally minute effect is produced.

In preparing the barretter a short piece of silver-platinum wire, after being drawn down to the requisite diameter, is formed into a loop, as shown in Fig. 1, and the terminals fastened to the leading-in wires, 2, 2. The tip of the loop is then immersed in nitric acid and a small portion of the film of silver is dissolved away

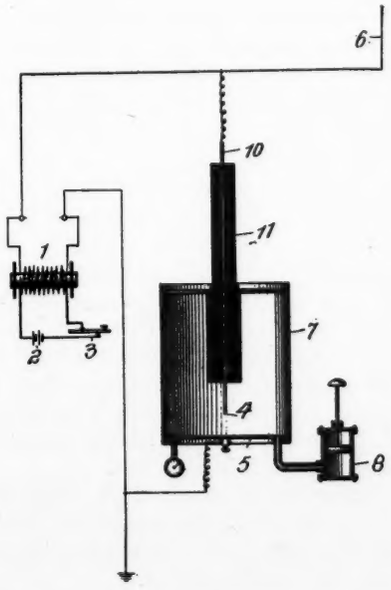



FIG. 7.—DEVICE FOR DECREASING THE EFFECTIVENESS OF THE SPARK-GAP.

from it without reducing the cross-section or mass at the terminals. The loop then has a resistance of from 30 to 150 ohms, which, when compared with an ordinary coherer, is exceedingly low.

As a means of avoiding radiation of heat, the loop is enclosed in a silver shell, 3, being clamped by a glass brace, 4, and supported by a corrugation in the brace and silver shell. To complete the device, the whole is enclosed in a glass bulb, 5, and the leading-in wires sealed at 6. A vacuum may be forced and maintained in the bulb, or it may contain air or paraffin. This is the Fessenden wave detector, and

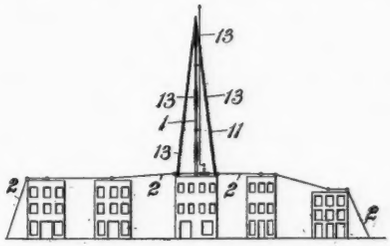



FIG. 6.—THE "WAVE CHUTE."

forms one of the most important advances in the art since its original inception.

The tuning device invented by Fessenden is shown in Fig. 2, and has for its object absolute accuracy and positiveness in the sending and receiving of electromagnetic waves, which renders the transmission of code wireless messages possible. In Fig. 2, 1 represents either a direct or alternating-current dynamo which charges the spark-balls, 2, to the requisite potential through the transformer, 3; a high resistance, 4, having a low inductance, is in series with the spark-gap. The transformer charges directly the condenser, 5, when the disruptive discharge takes place at 2.

The tuning device, 6, is constructed of one or more pairs of connecting wires arranged in a box containing oil insulating the wires. By this arrangement the capacity and inductance are so proportioned that the oscillation does not decrease in geometric retrogression, but is constant, and a pure sine wave results which is a great improvement over inductance coils.

This tuning grid, as it is termed, is also employed in the receiving circuit, as shown at 7; while at 8 the barretter is inserted.

Fig. 3 illustrates the Fessenden system complete. It will be observed that the antenna, 1, and the earth, $1^1$, are connected to the spark-balls through the tuning grid, 6, 6, forming the oscillating system. The switch, 3, is employed to cut out the oscillator circuit when receiving, although the generator is kept constantly in action, and when sending the messages the antenna is thrown in and out of tune by the key, 4. Figs. 21 to 27 represent a holder for the barretter, or wave detector, and 32 a pair of head telephones for translating the impulses into the Morse code; 20 and 25 show an automatic cutout.

Figs. 4 and 5 are photographic reproductions of the Fessenden system in operation between his stations in South Carolina and Virginia. The spark-gap and vibrator are shown to the right of Fig. 4, which is a front view of the apparatus, and the containing key case, barretter case and relay to the left. Fig. 5 is a rear view of the same equipment.

Two inventions to which I wish to call attention and are not shown in the photographs will be seen diagrammatically represented in Figs. 6 and 7. These are respectively a "wave-chute" and a device for increasing the effectiveness of the spark-gap.

As the object of the wave-chute has been described in the preceding part of the text and its mode of application shown in Fig. 6, little need be said about it. Suffice it for me to say that the grounded terminals of the oscillator sys-

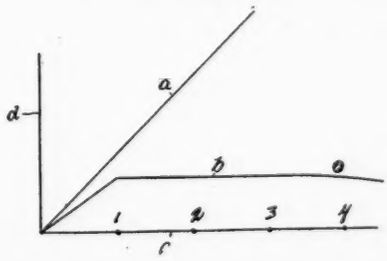



FIG. 8.—GRAPHIC RELATIONS.

tem, 2, 2, 2, 2, are led from the point where the instruments are located over the tops of buildings and other obstacles and then to the earth. Fig. 6 is the plan view of the scheme. The wave-chute or artificial ground should extend a distance from the antenna a quarter of the length of the wire to be emitted and in the direction of the station to be communicated with.

The device illustrated in Fig. 7 gives in a measure an idea of the brilliant discoveries made by Professor Fessenden in

the course of his investigations. In wireless telegraph practice it is necessary to reduce the length of the spark-gap to a certain minimum critical length. This is due to the fact that the resistance of the oscillator circuit must be less than four times the inductance, divided by the capacity. Any increase in the length of the gap transforms the oscillatory into a unidirectional current. The length of the disruptive discharge suitable for oscillations depends, therefore, upon the potential to which the oscillator system is charged. Now, the object of Fessenden's invention is to maintain a certain definite relation between the resistance, the inductance and the capacity of the oscillator circuit without regard to the potential charging said current. The curve, Fig. 8, shows the values graphically, where *d* represents the radiation, and *c* the potential at which sparking takes place; in air, at ordinary pressures, there is no increase in efficiency obtained in the effect of the oscillations regardless of the potential energy supplying the circuit, when a spark one inch in length has been reached. The curve describes the line *b*.

To eliminate this untoward effect Fessenden causes the disruptive discharge to take place in air under pressure, when an entirely new phenomenon results, and when a pressure of sixty pounds per square inch is reached and the emitting properties of the oscillatory current begin to increase, and at eighty pounds' pressure radiation becomes substantially proportional to the potential of the source, as shown at *a*. By referring to Fig. 7 it will be observed that the spark takes place between the point, 4, and the plate, 5.

These are some of the most important results achieved by Fessenden, and, in the light of recent discovery, the future of wireless telegraphy looms up with much actinic brilliancy, and likewise these indications would lead one to suspect that the marvelous achievements in the art will be eclipsed by those yet to come. That long-distance wireless telegraphy is possible with a nominal amount of energy is a foregone conclusion, and this is more than half the battle in the competition which is sure to follow.

With better, simpler and more economical means for transmission, together with a rapidity equal to the wire service, and certainty and accuracy of action, the day may not be very distant when there will be a royal battle waged between the old and the new methods.

## *ALTERNATORS FOR ELECTRICAL TRANSMISSION.*

BY ALTON D. ADAMS.

*(Copyright, 1902, by Alton D. Adams.)*

Dynamos in the generating station of an electric transmission system should be so numerous that if one of them is disabled the others can carry the maximum load. If only two generators are installed, it is thus desirable that each be large enough to supply the entire output, so that the dynamo capacity exceeds the greatest demand on the station by 100 per cent. To avoid so great excess of dynamo capacity it is common practice to install more than two generators.

Other considerations also tend to increase the number of dynamos in the generating station of a transmission system. Thus one transmission line may be devoted exclusively to lighting, another to stationary motors, and a third to electric railway service; and it may be desirable that each line be supplied by an independent dynamo to avoid any effect of fluctuations of one kind of load on the others.

At the generating station of the transmission system that supplies electric light and power in Portland, Me., the idea of independent units has been carried out with four 500-kilowatt dynamos, each driven by a pair of wheels fed with water through a separate penstock from the dam. Each of these dynamos operates one of the four independent transmission lines. Where a number of water-power stations feed into a single substation the requirement that each generating station have its capacity divided up among quite a number of dynamos may not exist, since one station may be entirely shut down for repairs and the load carried meantime by the other stations. A good illustration of this point may be seen at Manchester, where a single substation receives energy transmitted from four water-power plants. At one of these plants the entire capacity of 1,200 kilowatts is in a single generator.

The foregoing considerations as to the number of dynamos apply with equal force to both steam and water-driven stations, but other factors tend to increase the number of dynamos in water-power plants where the head of water is comparatively small. This tendency is due to the fact that the peripheral speeds of pressure turbine water-wheels should be about twenty-five per cent less than the velocity at which water would issue from an opening under the head of water at which these wheels operate in order to secure high efficiency. This velocity of water and therefore the peripheral speed of pressure turbine wheels varies with the square root of the head of water.

Since the peripheral speed of turbines is thus determined by the heads of water under which they operate, and since the diameters of turbines must increase with their capacities, the rate of revolution for pressure turbines under any given head decreases as the power goes up. For this reason it is often desirable to use a larger number of dynamos in a water-power plant than would otherwise be required in order to avoid very low speeds of revolution on the direct-connection to the turbines. A notable illustration of this practice exists in the great water-power plant of the Michigan-Lake Superior Power Company, at Sault Ste. Marie, Mich., where a generating capacity of 32,000 kilowatts is divided up between eighty dynamos of 400 kilowatts each. The head of water available at the pressure turbines in this plant is about sixteen feet, and their speed is 180 revolutions per minute. In order to obtain even this moderate speed under the head of sixteen feet it was necessary to select turbines of only 140 horse-power each. Four of these turbines are mounted on each shaft that drives a 400-kilowatt dynamo, direct-connected, so that there are 320 wheels in all. Had a smaller number of wheels been employed to yield the total power their speed and that of direct-connected dynamos must have been less than 180 revolutions per minute. As the cost of dynamos increases rapidly with very low speeds it is often cheaper to install a larger number of dynamos at a higher speed than a smaller number at a lower speed for a given total capacity.

The use of a larger number of units than would otherwise be necessary in order to avoid a very low speed is further illustrated by the 7,500-kilowatt plant of the Missouri River Power Company, at Cañon Ferry, Mont. This capacity is made up of ten generators, each rated at 750 kilowatts and direct-connected to a pair of pressure turbine wheels operating at 157 revolutions per minute, under a head of about thirty-two feet.

Under comparatively high heads of water pressure turbines operate at speeds that are ample for direct-connection to even the largest dynamos.

Thus in the Niagara Falls plant, where the head of water is 136 feet, each pair of turbines drives a direct-connected dynamo of 3,750 kilowatts at 250 revolutions per minute. In the rare case where the power to be developed is so great that the number of generators necessary to give security and reliability to the service

leaves each generator with a capacity larger than is desirable for structural reasons, the number must be increased simply to reduce the size of each generator. Such a state of facts existed at Niagara Falls, where the first station contains ten dynamos of 3,750 kilowatts each, and the second station, now nearing completion, will contain eleven units of like capacity.

In the greater number of transmission systems the generators are direct-connected to either steam engines or water-wheels and their speeds of rotation are largely determined by the requirements of these prime-movers. Steam engines can be designed with some regard to the desirable speeds for direct-connection to dynamos, but water-wheels are less flexible in this particular. Each type of wheel has its peripheral speed mainly determined by the head of water under which it may be required to operate, and variation from this speed means serious loss of efficiency. Of course any one of several speeds of rotation may be had with a given power by mounting one, two or four water-wheels on the same shaft, but complication and cost increase with the number of wheels, and it is doubtful whether more than two should be so mounted in an ordinary case.

With heads of water less than twenty feet, the speed of revolution of pressure or of impulse turbines is too low for the economic design of direct-connected dynamos. On the other hand, under heads of much more than 100 feet pressure turbines operate at rather high speeds in all except very large sizes. Either of these conditions can well be met by belt or rope driving from water-wheels to dynamos. It is much the more common to see water-wheels at a lower speed belted to dynamos at a higher speed, but in some instances, as at the lighting plant of Spokane, Wash., wheels of a higher speed are belted to dynamos of a lower speed. Another plan by which moderate dynamo speeds are obtained with water-wheels under rather high heads, mounts a dynamo at each end of the shaft of a large turbine or pair of turbines. This plan is followed at the plant of the Royal Aluminum Company, Shawinigan Falls, Quebec, where there are two pairs of horizontal turbine wheels, each pair developing 3,200 horse-power under a head of 125 feet, and driving a dynamo direct-coupled on each end of its shaft. Where vertical wheels are employed it is often more desirable to drive some standard type of dynamo with horizontal shaft by means of bevel gears than to design a special dynamo to mount directly on the vertical shaft. This latter plan is warranted in very large work like that at the Niagara Falls generating stations, where the twenty-one 3,750-kilowatt dynamos are direct-connected, each on the vertical shaft of a 5,000-horse-power turbine. This type of connection is not one that will be frequently followed, because of its large expense, but in at least one other important plant—that at Portland, Ore. —each dynamo is mounted directly on the shaft of its vertical turbine wheel.

Where water-wheels must operate under heads of several hundred feet it is usually necessary to abandon pressure turbines because of their excessive speeds, and to adopt one of the types of impulse-wheels. In this class of wheels the peripheral speed of highest efficiency is only one-half the spouting velocity of the water under any particular head. This gives the impulse-wheels about two-thirds the peripheral speed of pressure turbines of equal diameter and consequently about two-thirds as many revolutions per minute. But as the water may be applied at one or more points on the circumference of an impulse-wheel, as desired, such wheels may have much greater diameters than pressure turbines for equal power under a given head.

These properties of low peripheral speed, as to head and great diameter, as to power developed, fit impulse-wheels for direct-connection to dynamos where great heads of water must be employed and they are generally used in such cases. This is particularly true for the Pacific coast, where water powers depend more on great heads than on large volumes. In the generating plant of the Bay Counties' Power Company, at Colgate, Cal., the dynamos are direct-connected to impulse-wheels that operate under a head of 700 feet. The three 2,250-kilowatt dynamos in this plant are each mounted on a wheel shaft operating at 285 revolutions per minute, and each of the four 1,125-kilowatt dynamos is direct-driven by an impulse-wheel at 400 revolutions per minute. At the Electra, Cal., plant of the Standard Electric Company the impulse-wheels operate at 240 revolutions per minute under a head of 1,450 feet. Each of the five pairs of these wheels drives a 2,000-kilowatt generator, direct-connected. As the head of water at these wheels is 1,450 feet, its spouting velocity is about 300 feet per second, or 18,000 feet per minute. Each wheel is eleven feet in diameter, so that a speed of 240 revolutions per minute gives the periphery a little less than 9,000 feet per minute, or about one-half the spouting velocity of the water. These two great plants are excellent illustrations of the way in which impulse-wheels, under great heads, may be given speeds that are suitable for direct-connected dynamos.

Three types of alternators, the revolving armature, the revolving magnet, and the inductor, are used in the generating plants of electric transmission systems.

Revolving armatures are used in the dynamos of comparatively few transmission systems and hardly at all in those of recent date. The prevailing type of alternator for transmission work is that with internal revolving magnets and external stationary armature. This type is employed in the great water-power plants at Cañon Ferry, Mont., Sault Ste. Marie, Mich., and for the five generators last installed in the Niagara Falls plant. For the sixteen earlier generators at Niagara Falls the revolving magnets are external to the stationary armatures, but this construction has the disadvantage of high first cost and inaccessibility of the internal armature, and is not likely to be often adapted elsewhere.

Inductor alternators are those in which both the armature and magnet coils are stationary and only a suitable structure of iron revolves are employed in a comparatively small number of transmission systems, but this number includes some of the largest plants. The seven alternators in the Colgate, Cal., plant aggregating 11,250 kilowatts capacity, and the five alternators in the plant at Electra in the same state, with a capacity of 10,000 kilowatts, are all of the inductor type. As more commonly constructed the magnet winding of the inductor alternator consists of only one or two very large coils, which are in some cases as much as ten feet in diameter. The repair of these large magnet coils seems to present a more serious problem, in case of accident, than the repair of the small coils used on internal, revolving magnets. As far as satisfactory operating qualities are concerned, inductor alternators and those with revolving magnets seem to be on an equality, but for structural reasons inductor alternators will probably be built less freely in the future than in the past.

Nearly all long transmissions are now carried out with either two or three-phase current, approximately one-third of these plants being two-phase and the remainder three-phase. The most notable two-phase installation is that at Niagara Falls, where the original ten generators, as well as the eleven dynamos just added,

are all of the two-phase type. At Cañon Ferry, Mont., the first four of the 750-kilowatt-generators were two-phase, but the six machines of like capacity installed later are three-phase. In the latest plants of large capacity or involving very long transmissions three-phase machines have been generally employed. This is true of the Colgate and Electra plants in California, and of that at Sault Ste. Marie, Mich.

As to frequency, existing practice extends all the way from 133 cycles per second on the lines at Marysville, Cal., down to only fifteen cycles on the transmission for the Washington & Baltimore Electric Railway.

More common practice ranges between twenty-five and sixty cycles. Niagara Falls saw the first great plant installed for twenty-five cycles, and it remains one of the very few of that frequency that are engaged in the supply of light and power for general distribution. For transmission to electric railway lines a frequency of twenty-five cycles has been and is being widely used, prominent examples of which may be seen in the New Hampshire traction, the Berkshire, and the Albany & Hudson systems.

The strong feature of a system at twenty-five cycles is that it is well suited to the supply of continuous currents through rotary converters with reasonable numbers of poles, armature slots and commutator bars.

On the other hand, the cost of transformers is greater with current at twenty-five cycles per second than with a higher frequency, and this current is only just bearable for incandescent lighting and quite unsuited for arc lamps, because of the fluctuating character of the light produced. At fifteen cycles per second a current can be employed for incandescent lighting with satisfactory results only by means of some special devices, as lamps with very thick filaments, to avoid the flicker. Very low frequencies cut down undesirable effects in the way of inductance and resonance, but these effects can be avoided to a large degree in other ways.

Where power is the most important element in the service of an electric water-power and transmission system there is a decided tendency to adopt a rather small number of periods for the system, even at some disadvantage as to lighting facilities. This is illustrated by the transmission from St. Anthony's Falls, Minn., at thirty-five cycles, from Cañon City to Cripple Creek, Col., at thirty cycles, by the Sault Ste. Marie plant of 32,000 kilowatts at thirty cycles, as well as by the Niagara Falls plant of 78,750 kilowatts at twenty-five cycles.

Where the main purpose of a transmission system is the supply of light and power for general distribution, sixty periods per second are adopted as the standard in almost every case. This number of periods in comparison with a smaller one tends to increase the cost of rotary converters but decreases the cost of transformers, and is suitable for both incandescent and arc lighting.

More than fifty long transmissions at high voltages are now operating in the United States, among which are included that of 145 miles between Electra and San Francisco, that of 142 miles between Colgate and Oakland, and that at 50,000 volts between Cañon Ferry and Butte. Few, if any, transmission systems have recently been installed for frequencies above sixty cycles, and the older plants that worked at higher figures have in most cases been remodeled.

During the past decade the voltages of alternators have been greatly increased, but have not caught up with the demand for high pressures on long-transmission lines. Ten years ago when the first long transmissions were going into operation 2,000 volts was considered high for an alternator. As this voltage is too low for economy of conductors longer than three or four miles, the important early transmissions were all carried out with the aid of step-up transformers at generating stations. The practice then was, and to a large extent still is, to design the alternators for a transmission with a voltage well suited to their economical construction, and then give the step-up transformers any ratio necessary to attain the required line voltage.

Thus in the two water-power plants connected with the electrical supply system of Hartford, Ct., the alternators operate at 500 volts with transformers that put the line voltage up to 10,000. In the station on Apple River that supplies the lighting system of St. Paul, Minn., the alternators operate at 800 volts, and this is raised to 25,000 volts for the line. At Cañon Ferry the alternator voltage of 500 is multiplied by ten in the transformers giving 50,000 on the line.

Where the generating station of a transmission system is located close to a part of its load the alternators are given a voltage suitable for distribution, say about 2,400, and any desired pressure on the line is then obtained by means of step-up transformers. The Niagara Falls plants are an excellent illustration of this practice, the voltage of all the alternators there being 2,300, which is raised to 22,000 for the transmission of a part of the energy to Buffalo. A similar practice is followed in the water-power plant at Ogden, where the generators furnish current at 2,300 volts for local distribution, and transformers raise the pressure to 26,000 volts for the transmission to Salt Lake City. In the 32,000-kilowatt plant at Sault Ste. Marie, Mich., the alternators operate at 2,400 volts and a large part of their load is local, but this voltage will no

ALTERNATORS IN TRANSMISSION SYSTEMS.

| Location of System. | Number at Plant. | Kilowatts Each. | Alternator Voltage. | Phase. | Cycles. | R. P. M. | Type of Magnet. | Method of Connections. |
|---|---|---|---|---|---|---|---|---|
| Niagara Falls | 16 | 3,750 | 2,300 | 2 | 25 | 250 | External revolving. | Direct. |
| " " | 5 | 3,750 | 2,300 | 2 | 25 | 250 | Internal. | " |
| Colgate to Oakland | 3 | 2,250 | 2,400 | 3 | 60 | 285 | Inductor. | " |
| " " | 4 | 1,125 | 2,400 | 3 | 60 | 400 | " | " |
| Electra to San Francisco | 5 | 2,000 | .... | 3 | 60 | 240 | " | " |
| Portsmouth to Pelham | 1 | 2,000 | 13,200 | 3 | 25 | 83.3 | Internal. | " |
| " " | 2 | 1,000 | 13,200 | 3 | 25 | 94 | " | " |
| Virginia City | 2 | 750 | 500 | 3 | 60 | 400 | External. | " |
| Ogden and Salt Lake | 5 | 750 | 2,300 | 3 | 60 | 300 | Internal. | " |
| Chaudiere Falls | 2 | 750 | 10,500 | 3 | 66.6 | 400 | " | " |
| Yadkin River Falls | 2 | 750 | 12,000 | 3 | 66 | 166 | " | " |
| Lewiston, Me | 2 | 750 | 10,000 | 3 | 60 | 180 | " | " |
| Farmington River to Hartford, Ct | 2 | 750 | 500 | 3 | 60 | .... | " | " |
| | 2 | 600 | 500 | 2 | 60 | .... | " | " |
| Cañon Ferry to Butte | 10 | 750 | 550 | 3 | 60 | 157 | " | " |
| Apple River to St. Paul | 4 | 750 | 800 | 3 | 60 | 300 | " | " |
| Edison Co., Los Angeles | 4 | 700 | 750 | 3 | 50 | .... | " | " |
| Madrid to Bland | 2 | 600 | 605 | 3 | 60 | 90 | " | " |
| Cañon City to Cripple Creek | 3 | 450 | 500 | 3 | 30 | .... | ..... | " |
| Sault Ste. Marie | 80 | 400 | 2,400 | 3 | 30 | 180 | " | " |
| St. Hyacinthe, Que | 3 | 180 | 2,500 | 3 | 60 | 600 | " | " |
| Great Falls to Portland, Me | 4 | 500 | 10,000 | 3 | 60 | 225 | " | " |

doubt be raised by transformers when transmission lines are operated.

For generating stations that carry little or no local loads the cost of transformers can be saved if the generators develop the voltage required on the transmission lines. This possible saving has led to the development of alternators that generate voltages as high as 15,000 in their armature coils. Such alternators have stationary armatures in all cases and are of either the revolving magnet or inductor type.

At the present time more than a score of transmission systems in the United States operating at 10,000 or more volts develop these pressures in the armature coils of their alternators, and the number of such systems is rapidly increasing. It is now the rule rather than the exception to dispense with step-up transformers on new work where the line voltage is anything under 15,000. Perhaps the longest transmission line now in regular operation with current from the armature coils of an alternator is that at 13,200 volts between the generating station at Portsmouth and one of the substations of the New Hampshire Traction system at Pelham, a distance of forty-two miles.

In at least one transmission system now under construction, that of the Washington, Baltimore & Annapolis Electric Railway, the voltage of generators to supply the line without the intervention of step-up transformers will be 15,000.

The company making these alternators is said to be ready to supply others that generate 20,000 volts in the armature coils whenever the demand for them is made. In quite a number of cases alternators of about 13,000 volts have been installed for transmissions along electric railway lines.

| Systems Using High-Voltage Alternators. | Alternator Voltages. |
|---|---|
| Lighting and Street Railway, Manchester, N. H. | 10,000 |
| Lighting and Street Railway, Manchester, N. H. | 12,500 |
| Lighting and Power, Portland, Me. | 10,000 |
| Lighting and Power, North Gorham, Me. | 10,000 |
| Mallison Power Co., Westbrook, Me. | 10,000 |
| Lighting and Power, Lewiston, Me. | 10,000 |
| Electric Railway, Portsmouth, N. H. | 13,200 |
| Electric Railway, Pittsfield, Mass. | 12,500 |
| Ludlow Mills, Ludlow, Mass. | 13,200 |
| Electric Railway, Boston to Worcester, Mass. | 13,200 |
| Electric Railway, Albany & Hudson, N. Y. | 12,000 |
| Empire State Power Co., Amsterdam, N. Y. | 12,000 |
| Lehigh Power Co., Easton, Pa. | 12,000 |
| Hudson River Power Co., Mechanicsville, N. Y. | 12,000 |
| Light and Power, Anderson, S. C. | 11,000 |
| Fries Mfg. Co., Salem, N. C. | 12,000 |
| Light and Power, Ouray, Col. | 12,000 |
| Washington & Baltimore Electric Railway | 15,000 |
| Chamblay Mfg. Co., Chamblay, Que. | 12,000 |

This list of high-voltage alternators is not intended to be exhaustive, but serves to indicate their wide application. If such alternators can be purchased at a lower price per unit of capacity than alternators of low voltage plus step-up transformers there is an apparent advantage for transmission systems in the high-voltage machines. This advantage may rest in part on a higher efficiency in the alternators that yield the line voltage than in the combination of low-voltage alternators plus step-up transformers. It is not certain, however, that depreciation and repairs on the generators of high voltage will not be materially greater than the like charges on generators of low voltage, and some advantage in price should be required to cover this contingency.

Just how far up the voltage of alternators can be pushed for practical purposes is uncertain, but it seems certain that the limit must be much below that for transformers where there is ample room for solid insulation and the coils can be immersed in oil. The use of generators at 10,000 volts and above tends to lower the volts per mile on transmission lines, because it seems better in some cases to increase the weight of line conductors rather than to add step-up transformers, as in the forty-two-mile transmission from Portsmouth to Pelham.

## *ELECTRICAL NOTES FROM EUROPE.*

BY C. L. DURAND.

A German firm, the Incandescent Lamp Company, of Berlin, is commencing to manufacture the new osmium lamps under the Auer von Welsbach patents and to put them on the market. It appears that the company has paid $160,000 for the patent rights. The price of the lamps is $1.25, and the old lamps will be taken back for twenty cents, provided they still contain the double osmium filament. It is claimed that the osmium lamps consume only 1.5 watts per candle-power, which gives them an economy of fifty per cent or more over the 3 or 3.5-watt lamps. A series of figures as to the life and efficiency of the new lamp has been published according to the experiments which have been made by M. Remane, one of the company's engineers. For instance, a thirty-nine-volt lamp at the start consumed 1.54 watts per candle, giving thirty-three candle-power; after 500 hours it fell to 32.4 candle-power and took 1.49 watts per candle, while at the end of 1,000 hours, at the same voltage, it showed 31.7 candle-power and a consumption of 1.50 watts. The osmium lamp, as was shown in some previous experiments, shows the curious anomaly in that its efficiency rises in some cases after a certain number of hours burning. The contrary case, however, took place with a fifty-five-volt lamp giving at the start 34.7 candle-power and 1.43 watts per candle. At the end of 1,000 hours it showed 31.6 candle-power and 1.58 watts; but another test on a fifty-three-volt lamp showed 1.51 watts at the start and 1.44 watts at the end of the test. This phenomenon seems to be of an irregular nature; at all events, the efficiency is remarkably high and the lamp seems to be durable. An interesting test was to compare two osmium lamps and two carbon lamps of thirty-two candle-power, using fifty-five volts for both lamps. The osmium lamps took 0.9 ampere and the carbon 1.8 amperes, which clearly shows the difference in energy consumed. It is stated that the light from the osmium lamp is of a clear white, somewhat resembling that of a Nernst lamp.

---

M. de Paun, a Belgian engineer, has remarked a curious phenomenon relating to the passage of currents through wires covered with an oxidized layer. When, for instance, telephone wires which have a slight coating of oxide are placed side by side and in contact, a short-circuit does not seem to take place, as the conversation may still be carried on in each circuit. If the layer is sufficiently thick the same holds good for an alternating current, such as is furnished by a magneto. On the contrary, continuous current seems to pass easily through the layer. A phenomenon of the same nature was observed last summer on the Paris-Brussels telegraph line. A short-circuit had been formed where the two wires came in contact over a length of thirty feet or more. Under these conditions the telegraph instruments failed to work, but the telephone could still be operated over the line. Another instance of the same kind occurred on the Brussels-Lille circuit which is used both for telegraph and telephone purposes. The bronze wires forming the line were suspended on the top of the poles, while below them ran a number of lines of iron wire. The bronze wires became loaded with ice which caused them to sag and come in contact with the iron wires underneath. Notwithstanding the apparent short-circuit which was thus formed, the telephone continued to work. It seems, therefore, that there is a difference in the conductivity of an oxidized layer for direct and for alternating or pulsatory currents.

## SOME VARIABLE SPEED MOTOR DRIVES.

BY THOMAS J. FAY.

It is scarcely necessary to more than state that the question of the application of electrical motors to machine tools has been settled in favor of the direct attachment of the motor to the individual tool in every case, rather than the grouping of tools and the intervention of shafting units; that is to say, it is not so long ago that the cost of the individual motor was considered excessive, and it was the practice to use one motor for kindred groups of tools, rather with the view of saving in point of first cost. That the grouping method was a considerable advance on the old belting and shafting method was proven conclusively in the course of events, and admitting that the grouping method was a good thing, it was not difficult to discover that all the qualities to be derived were not taken advantage of. In other words, grouping was a good start, but the application of individual motors to the respective tools was found to be a good finish.

There are two principles involved in this matter of the electrical application of motors to machine tools, one of which is the question of a moderate first cost, with a moderate result. The other is the question of the highest possible first cost with the least possible cost of maintenance. It is not to be supposed that a manufacturing company, indifferently supplied with investing cash, would care to throw out its old-fashioned tools and take up the question of the most complete and appropriate method of direct tool drive, involving the cost of an individual motor for every tool. On the other hand, it is now considered very safe to say that a company, expecting to survive under the future conditions of competition, will be able to survive unless they make very heavy cuts at a very rapid rate, and some of us who have tried the two methods are perfectly aware of the fact that a belt transmission, involving cone pulleys, is wholly incompetent. The writer, in his own work, has settled this question once and for all, and to illustrate this point it is only necessary to say that a machinist who has been broken in on, we will say, a heavy shafting lathe equipped with a direct-driven motor, will never again be able to do good work on a belted lathe, because on the direct-driven lathe he forms the habit of operating under the maximum conditions of feed at the highest possible speed, and as soon as he is put back onto the old belted lathe he finds himself unable to operate under his then accustomed conditions of feed and speed.

FIG. 1.—A TURNING FROM A GUN BARREL; A CUT TAKEN WITH AIR-COOLED TOOLS.

Fig. 1 shows a cut taken on a direct-driven lathe with air-cooled tools, and represents a turning from a gun barrel representing a three-quarter-inch cut with a one-sixteenth-inch feed at fifty feet per minute. This cut is by no means a maximum, but this cut is utterly impossible under any of the old conditions under which tools were driven in the past. As an offset to this fairly good result, Fig. 2 represents a cut from similar metal taken on a belted lathe, showing a one-quarter-inch cut at a one-thirty-second-inch feed at twenty-eight feet per minute. In this latter case, the belt was doing all that it could do, and where we might consider that the wider belt more in tension would be able to handle the increase in work noted in Fig. 1, yet even so, we have to consider that the lathes are made in a certain way, and that men are accustomed to handle that kind of work, and to get them out of their rut would be practically impossible.

FIG. 2.—CUTS FROM SIMILAR METAL AS FIG. 1.—BELT-DRIVEN LATHE.

It is noted that machine tool builders and machine tool users are wont to attain the maximum result without respect to first cost. Nevertheless, some machine tool builders, and some users of machine tools, do complain of the first cost of a variable speed motor such as could be used for driving a lathe, a planer or shaper under the most severe conditions of service, with the view of taking off the maximum amount of metal in the minimum time with the least expense of labor, and really with the least cost of power; it being the case in this connection that while a lathe, planer, shaper or a mill may require more power while it is being driven under maximum conditions, yet even so, the useful component is more favorable, because the friction component is a very considerable factor, and the only way to attain the maximum efficiency is to take off the maximum amount of metal in a given time.

Illustrating the facility with which electrical motors can be directly attached to machine tools is Fig. 3, which represents a Stockbridge shaper. This Stockbridge shaper is equipped with a motor, as shown, the motor itself being comparatively small, yet even so, very powerful, and designed for speed changes over very considerable ranges. That this shaper is one of the most modern and, altogether, most effective machines now to be had has been demonstrated beyond a question. That the results attained are due in a large measure to the individual motor attached, is believed; that the shaper itself would be even nearly as good if belt-driven, is doubted, and that the cost of the individual motor in this case is a debar to its use, is extremely doubtful. Yet, even so, an old-fashioned mill manager would squeak like a rusty hinge were he told he would have to pay for an individual motor instead of for a leather belt. That the old-fashioned squeaky mill manager will be a factor in the future market is impossible.

Fig. 4 represents a direct-driven lathe. Even a casual observer will note that there is neither an excess of gearing nor a single belt. This is purely a direct-driven lathe (and the writer calls particular attention to the fact that it is a pure direct drive, not a makeshift), but there are many people, even in the machinery trade, who are wont to refer to the motor that is not direct-driven as a direct-driven motor. In other words, many tool builders are inclined to put a motor on stilts, employ a cone pulley with short belt centres, and call it a direct-driven machine. Such is not the case, however. All that

can be said for any such machine is that it is self-contained, and the difference between the self-contained and direct-driven machine is sufficiently obvious to require no further discussion.

Another example of the direct drive is shown in Fig. 5, which represents a grinder, the abrasive wheels of which are directly mounted on a motor spindle.

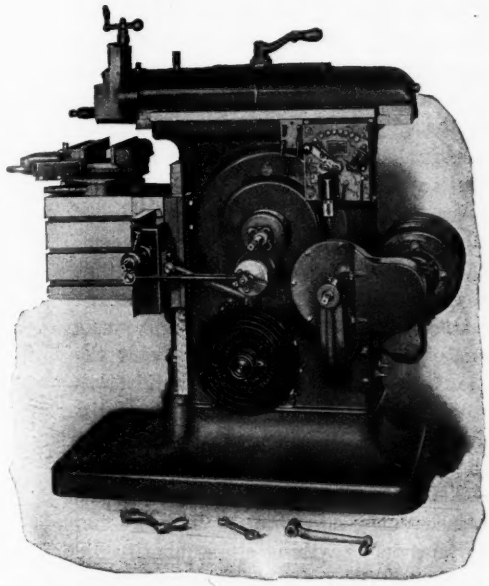


FIG. 3.—ENCLOSED MOTOR DIRECT-CONNECTED TO STOCKBRIDGE SHAPER.

Many attempts have been made to accomplish this result, but it is a well-known fact that a grinder to be successful must operate at a certain high speed, and the speed variations must be such that the peripheral velocity of the abrasive discs must be constant. The abrasive discs are worn down by service, and, as a result, the driving medium must have speed attachments such as will readily permit of varying the angular velocity in a ratio suitable for the acquirement of the desired result; *i. e.*, a constant peripheral velocity of the abrasive discs. The machine in question not only operates at the required high speed, but by the simple movement of a lever the speed may vary over broad ranges, thus making it possible to establish a constant peripheral velocity of the abrasive disc, or any special case varying that velocity, over broad ranges, to satisfy the especial conditions that may prevail.

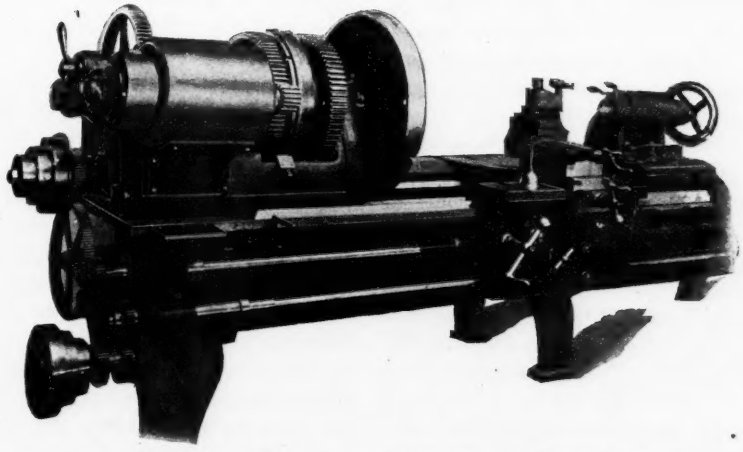


FIG. 4.—ENCLOSED MOTOR, DIRECT-CONNECTED TO LARGE LATHE.

Referring to the question of variable speed motors, with a view to discussing details, it is fair to point out that there are two or three methods in vogue, each of which may be entitled to some especial mention, and among which the multivoltage method is more or less conspicuous. By the multivoltage method we mean a combination of motors and generators with a multiple of circuit leads, so devised that the field of the respective motors is constantly excited, but the armatures of the respective motors are impressed with a variable electromotive force, thus effecting the speed changes. This arrangement requires the use of main generators, auxiliary multivoltage generators, a main switchboard and auxiliary multivoltage switchboard, as well as a plurality of leads, such as 3, 5, 7, and so on, with the view to operating the motors under conditions as aforesaid, in which the impressed electromotive force on the respective armatures of the motors may be varied over broad ranges, with a view of varying the speeds of the motors. That this system is a complicated one and extremely high in point of first cost has long been known. As a matter of fact, in England, some ten years ago, the five-wire system was in vogue. Equally, as a matter of fact, in America, ten years ago, the Edison three-wire system was in vogue. That three wires were less troublesome than five has been proven by the very fact that the English five-wire system has ceased to exist, and that three wires represent one more than the desired amount is equally proven from the fact that the two-wire system has prevailed in every case where it has been possible to transmit the current the required distance without an excessive drop. The writer, in the course of events, has examined very many of the examples of the electrical power installations extant, and in almost every instance he has been told by users of motors that the multivoltage system has two minus qualities—*i. e.*, too much complication and too little power at the minimum speeds. As a matter of fact, a multivoltage motor that will give you twenty horse-power at

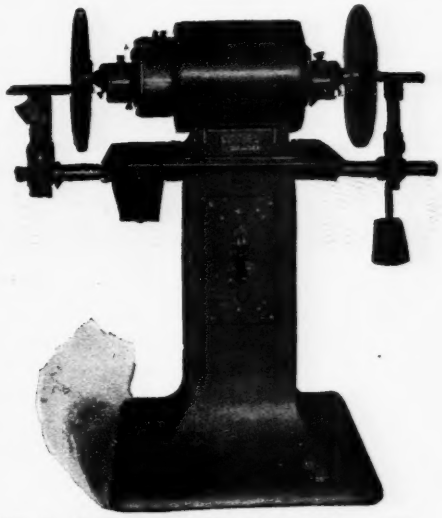


FIG. 5.—ENCLOSED MOTOR, DIRECT-CONNECTED TO GRINDER.

2,000 revolutions per minute, will give you ten horse-power at 1,000 revolutions per minute and five horse-power at 500 revolutions per minute. Equally, as a matter of fact, nearly every case of machine tool drive requires a reversal of these conditions. What the tools require is the twenty horse-power at 500 revolutions per minute. In other words, the average condition that prevails is that heavy cuts are made at comparatively low speeds, and finishing cuts are made at comparatively high speeds. That the finishing cut requires a comparatively small amount of power goes without saying, and that the heavy cut requires the maximum power is equally plain.

There was a time when none of us knew how to vary the speed of a motor, excepting by varying the voltage impressed on the armature, or what amounts to the same thing, by insertion of resistance in the armature circuit; but we all learned a long time ago that "necessity is the mother of invention." In this case,

however, the writer believes that invention has followed necessity. A casual mention of a resistance in the armature method of speed control is all that is necessary. $C^2R$ drop in the rheostat, when any such method is employed, means a waste of energy that would drive Carnegie to the poorhouse, and while we are willing to admit taking his word for it that he wishes to die poor, we know of no better way that he might accomplish his end than to employ rheostats in the armature circuits of motors.

There is still another and conspicuous method of speed control, and in many instances it is admirable, particularly if we refer to certain small work of no very great responsibility, in so far as the individual cases are concerned; that is to say, the means by which the sectional area of the core of the magnetic circuit in motors is varied by the withdrawal of a portion of the magnetic material, but since this method involves a variation in the flux density in the air-gap of the motors, sparking ensues at the higher ranges, and the speed control resulting is limited to certainly less than 200 per cent of the initial speed of the motor on which such a method is employed, whereas what the market requires is 400, 500, 600, 700 and 800 per cent of the initial speed, and unless that very considerable increase in speed variation can be realized inventors will go on inventing mechanical methods of speed changes which, however bad, are better than nothing.

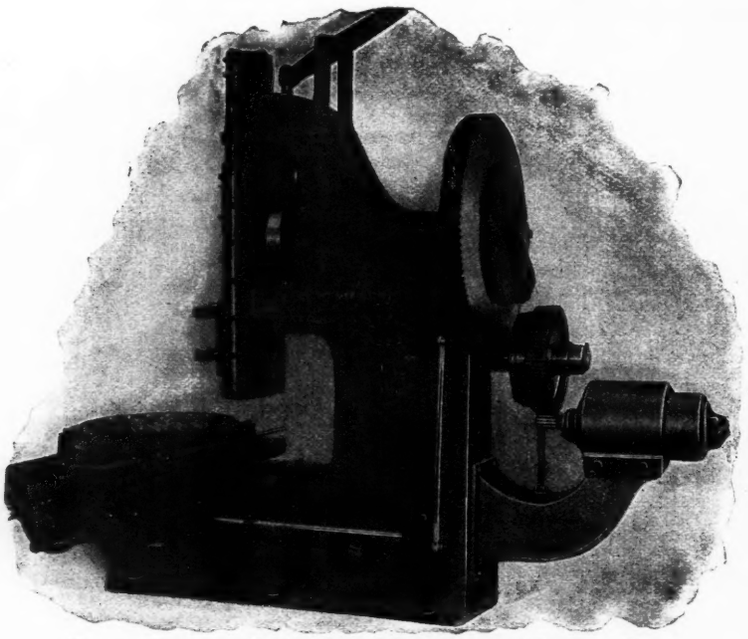


FIG. 6.—ENCLOSED MOTOR, DIRECT-CONNECTED TO NOTCHING PRESS.

The proper system of variable speed motors must have the one qualification that is desirable in the driving of machine tools, *i. e.*, the speed changes may be anything that a machine tool requires, limited only by the peripheral velocity of the armature on the upper register and the purchaser's pocketbook on the lower register.

It is perfectly obvious that a motor that has a speed change of 7 to 1 will be more expensive than a motor that has a speed change of 2 to 1. If the machine tool does not require a speed change of 7 to 1, then to pay for a motor that will give that speed change is to effect a futile investment. Nevertheless, there are many instances in which a speed change of 4, 5, 6, 7, and 8 to 1 is absolutely necessary, and unless these speed changes can be had a mechanical means of speed changing must be devised.

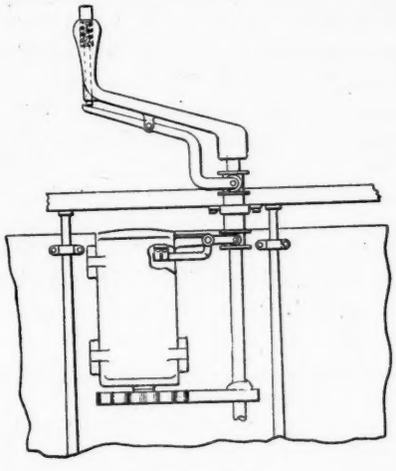
In these days, when output is seriously throttled because of the disinclination of men to turn out the required amount of work, it is a particular advantage to be able to establish a condition that is satisfactory to the company manufacturing a given product, especially since that condition offers no hardship to the man that does the work. That a workman is entitled to "fair day's pay for a fair day's work" is indisputable, but that the workman should produce the fair day's work is equally indisputable. In these strenuous times, to accept the judgment of an old-line machinist as compared with the conditions that exist is utterly impossible, and to try to bulldoze a workman into doing that which is self-evidently necessary is to court a kind of trouble that never pays, and to use persuasion on that workman is to waste time. He is actuated by motives that, while indeed perfectly pure, are based on a practice that is obsolete, and although it may be difficult, yet even so, it is not impossible, under the conditions established by the use of a proper system, to cut out all question of "piece-work," "sweat-shop systems" and other bunco games; yet withal make it possible to turn out as much work as can be turned out by a given machine; the machine itself being the guide and not the workman. It never has paid, and never will pay, in the writer's judgment, to employ dissatisfied men, and this is equal to saying that a condition that makes one man dissatisfied is a condition that will make any other man dissatisfied. It being the case that in the old days a machinist was more or less a king, companies were satisfied to accept the amount of work that a skilled artisan would turn out, and the skilled artisan considered that if he turned out good work it was more important than anything else—quantity did not count. That the American manufacturer can build bridges in Africa in competition with British bridge builders is utterly impossible to suppose if the American manufacturer accepts the dictum of the old-fashioned seven years' apprentice, who is expected to know everything about everything, whereas now the workman is a specialist and is required to know only a single thing. His judgment as to accuracy is of no importance whatever; in fact, he is merely expected to chuck or centre his work, start his motor and the modern machine tool does the rest.

## *International Association of Municipal Electricians.*

The executive committee of the International Association of Municipal Electricians will hold its annual meeting at Atlantic City on Washington's birthday, February 22. The members will leave New York *via* the New Jersey Central Railroad on Saturday, February 21, on the afternoon train. For several years past it has been the rule to hold this meeting on Washington's birthday, and this has become quite a feature of the association. This meeting has always been largely attended by members and friends of the association, and it is expected that this coming meeting will be even more successful than heretofore.

# Electrical Patents.

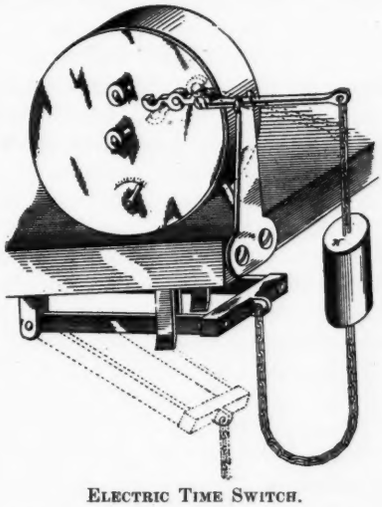
The General Electric Company controls, as assignee of Mr. Frank E. Case, of Schenectady, N. Y., a patent on an electric brake invented by Mr. Case. The object of this invention is to provide a mechanical and an electrically operated brake which will permit independent control of the movements of a car by either system of operation and by the same controlling handle or lever, thereby avoiding mistakes due to confusion of the motorman in critical emergencies and rendering the control of the car more flexible than is possible by either system used alone. In carrying out the invention, the usual spindle or shaft is arranged on the platform, and by turning the same, the electric brakes are first set with progressively increasing power and simultaneously the slack of the hand-operated chain is taken up. Therefore, upon a continued movement of the operating device the mechanical brake will also be set. Means are also provided for interrupting the electric brake circuit at will, so as to permit either the mechanical or the electric brakes being used alone when desired. This provision is of special advantage in permitting short and quickly



ELECTRIC BRAKE.

modulated applications of the motorman when closely following another vehicle along the track, or when moving through a crowded thoroughfare.

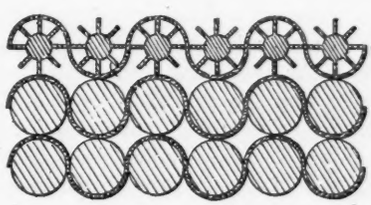
An ingenious Yankee of Waterbury, Ct., Mr. William B. Coulter, has patented a very simple and effective time switch, particularly adapted for use in connection with the lighting of store windows and analogous places that it is desired to illuminate each evening when such places are not occupied and where the lights are to be extinguished at a predetermined time without the presence of an attendant. Secured to the under side of a horizontal shelf is arranged an electric switch of the ordinary lever type, this switch controlling the lighting system. Instead of



ELECTRIC TIME SWITCH.

a handle, the cross-bar of the knives is provided with an eye and to the same is secured a chain carrying a weight sufficient to open the switch. The weight is arranged to be supported by a lever attached thereto and adapted to rest upon a post fastened to the edge of the shelf and having a forked upper end. An ordinary alarm clock is placed upon the shelf and one end of the lever is engaged with the winding stem of the alarm, this stem being provided with a special form of key having concave sockets, in which a knob formed on the end of the lever engages. It is believed that the mode of operation will be clearly apparent by referring to the accompanying illustration. The clock is first wound and the pointer set to the time desired for extinguishing the lights, after which the lever is placed upon the post and hooked under the key. The weight is thus suspended from the outer end of the lever, after which the switch is closed. With the parts in this position, upon the arrival of the time for extinguishing the lights, the alarm mechanism of the clock releases the key, causing the same to unwind. This in turn frees the lever, permitting it and the weight suspended thereby to drop, thereby opening the switch and consequently cutting out the lights.

A French engineer, Auguste Bainville, of Nanterre, France, has patented in this country an electric accumulator plate, especially useful in a form of battery patented by him in 1901, and having winged rods or elements for the accumulators. The principle of the present invention consists in insulating plates of opposite polarity, particularly with regard to movable elements, by placing between the elementary rods, the assemblage of which constitutes an electrode, a sheet of insulating material, which is porous or perforated, so as to give the electrolyte access to the rod. This sheet is corrugated, so as to pass around adjacent rods of the same plate, alternately covering half of the circumference of each rod in such a manner as to cover the face of one and the back of the next. The inventor claims that by this arrangement he modifies in a favorable manner the distribution of the current between the various plates of an element provided the rods of two adjacent plates, which are placed opposite each other, are separated by the insulating partition, while those which are not arranged in line are not separated by any insulating material. It results, therefore, from this arrangement that the imperfection in the distribution of the current between the plates, which may occur through the cylindrical shape of the elements or rods, is for the greater part eliminated. Another advantage resides in the fact that the various plates of an element can be packed closely together,



ELECTRIC ACCUMULATOR PLATE.

consequently reducing the size of the accumulator and the interior resistance of the element.

## *Tributes to the Memory of John W. Mackay.*

Mr. Frank A. Burrelle has just delivered to the Postal Telegraph-Cable Company twenty albums containing the published obituaries of the late John W. Mackay. The labor of gathering and placing in album form was begun last July. There are 5,480 clippings, each set covering 1,536 pages of Irish linen leaves, ten by twelve inches. This is the largest collection of material ever gathered concerning the death of a private individual, and the kindly expression of the press of the country was unanimous.

Four sets of books were ordered by the Postal Telegraph-Cable Company, one set being designed for Mrs. Mackay, the second for Clarence H. Mackay, one for the Postal Telegraph-Cable Company and one for the Commercial Cable Company.

# *Reviews of Current Engineering and Scientific Literature.*

### *Calculations of the Induced Electromotive Force and the Form Factor of Alternators.*

This is the first section of a serial by M. C. F. Guilbert, and takes up first the particular case of an alternator having a sinusoidal distribution of flux. A conductor revolving in a uniform field would be the seat of a sinusoidal electromotive force. This forms an ideal case. In practice, the flux passes more or less radially, so that distribution is not uniform. Assuming the particular case of a sinusoidal distribution, a conductor moving through this field would be the seat of a sinusoidal electromotive force, for which an equation is deduced in terms of the frequency, number of poles, number of conductors in series, and the total flux per pole, which equation involves the coefficient 2.22. This distribution of the flux will be obtained by properly shaping the polar face. Assuming the flux to pass radially from all points, the shape of the face should be such that the air-gap varies according to the sine law. This is only true when the air-gap forms almost the entire reluctance of the magnetic path. An approximate solution is found by making the polar surface that of a circular cylinder, the radius of which can be determined. A sinusoidal distribution of the flux is only necessary when there is but a single slot per pole per phase. The use of many slots per pole per phase diminishes, or even eliminates certain harmonics. The author then considers the case of an alternator in which the electromotive force induced is not sinusoidal. In this case it is necessary to introduce the Kapp coefficient, an equation for which is then deduced. This is shown to be independent of the minimum and of the maximum, and of the law of flux distribution, and is equal to twice the ratio of the effective electromotive force to the mean electromotive force.—*Abstracted and translated from the Revue Technique* (*Paris*), *January* 25.

### *Rougé and Faget's Rectifier.*

In this article M. A. Delasalle first gives a theoretical discussion of rectifiers and their operation. He then passes to a description of the Rougé and Faget rectifier. This consists of a four-pole Gramme ring, wound in series with twenty-five coils of ten turns each. The core is built up of sheets grooved on the interior, in which grooves the wires are wound. Within this ring is a second ring which constitutes the moving part. This is mounted on a vertical shaft, and carries on its upper end slip rings through which current is fed to a winding, and brushes which collect the rectified currents. The moving part, which corresponds to the revolving field, was made in the ring form in order to maintain a constant reluctance in a magnetic circuit in all positions. The commutator, which is fastened to the stationary part, contains twice as many segments as there are coils. Alternate ones are connected to the windings, the remaining ones being connected to the others through a resistance. The brushes which revolve are pressed against the surface of the stationary commutator by a counter-weight which is thrown out by a centrifugal motion. In action, current is collected from segments connected directly to the coils, but the commutation takes place at the other segments. In operation, the machine starts as an induction motor, and rapidly comes up to synchronism. Its characteristic is such that when used for charging batteries the terminal voltage increases with the decreased output, thus permitting an overcharge to be made automatically. Tests of a machine of this character having a capacity of four kilowatts show a power-factor of eighty-eight at half load, eighty-six at full load, with an efficiency rising continually from sixty-six per cent at half load to seventy-nine per cent at full load. *Abstracted and translated from the Revue Pratique De L'Electricite* (*Paris*), *January* 20.

### *A Study of Electrode Heating Caused by Sparks.*

Señor E. Villari has made a careful study of the heating of spark-gap electrodes, due to discharges between them. In these measurements a thermopile was used, and sparks passed between this and pointed, spherical or plate electrodes. It was found that the heating due to the discharge of a condenser is probably dependent upon the length of the gap. Heating increases with the charge and with the potential. It increases with decreasing pressure in nitrogen. In this latter case the heating caused was two and one-half times that when the sparks passed through hydrogen. Discharges from a Wimshurst machine heated the thermopile more if this was negative than if it was positive, the other electrode being either a ball or a plate. Using two thermopiles as electrodes, the heating changed but little with the change in the spark-gap. Measurements of the current discharge were made, and it was found that there was no change in intensity when the direction of discharge was reversed. Sparks from an induction coil passed between thermopiles or a thermopile and a ball, heated the thermopile three to four times as much when this was negative as when it was positive. In rarefied nitrogen the resistance of the gap is much less, so that the charging current is greater and the electrodes are heated much more intensely. Experiments were made by enclosing the gap in a vessel filled with different gases. In hydrogen the cathode heated more than the anode, but the heating for the same charging current was less than when nitrogen was substituted. The resistance opposed by a layer of hydrogen or nitrogen 12.86 millimetres thick was equal to that of a column of water fifteen millimetres thick and ninety-nine and fifty-nine millimetres long, respectively: A layer of hydrogen thirty-six and one-half millimetres thick has a resistance approximately equal to that of a layer of carbon dioxide forty-nine millimetres thick. Hydrogen as a gas has a greater resistance than air or carbon dioxide. Analogous results were found by employing an electric arc, hydrogen, as before, offering a greater resistance than air.—*Abstracted and translated from the Physikalische Zeitschrift* (*Berlin*), *February* 1.

### *Time Changes in the Magnetic Constants of Iron.*

It has been known for some time that solid bodies do not possess the stability which previously had been considered a characteristic of that state, but that, on the other hand, a gradual and continual change goes on which modifies their properties and molecular structure. One case of this is the change which takes place in permanent magnets, and which is known as "seasoning." This has received some study, but a study of the changes taking place in the iron itself has been neglected. This article gives a summary of a careful study made by Señor Mazzato of these changes. The results are interesting and thought to be of some practical value. It was found that iron annealed at a red heat for a considerable time changed its

magnetic constants, although maintained at a temperature much below that at which it had been annealed. The stable value which it finally reaches depends upon the temperature at which it is kept. These changes consist in a diminution of the susceptibility of about seventy-five per cent, and an increase in the magnetism of 200 per cent. The coercive force also increases. The changes are the more marked, and take place the more slowly, the lower the temperature. It is thought that the increase in the hysteresis loss does not depend upon a diminution of the permeability, but upon the increase of the coercive force. The researches have been carried on at temperatures varying from 360 degrees down to ordinary temperatures, the change taking place in all cases. The greatest change takes place in the best quality of iron. It is somewhat less in Swedish iron, and is still less in steel. All observed changes were greater at 100 degrees, but did not differ materially between 60 degrees and 100 degrees. The velocity of these changes decreases rapidly with lower temperatures, so that at 100 degrees the stable condition is reached in 100 hours, but at ordinary temperatures it may take some years.—*Abstracted and translated from the Electrotechnische Anzeiger (Berlin), January 25.*

***Precipitation of Coppery Cyanide Solutions.***

The cyanide process for extracting gold from the ore has come into wide use within the past ten years, and any information concerning the best way of treating the ore is of interest and value. In this article, Mr. Paul S. Browne gives some of his experiences and results. A small amount of copper in the solution acts beneficially, provided no deposit of this metal takes place on the zinc, and great precautions should be taken to prevent this. One way is to increase the strength of the cyanide solution and thus dissolve any copper which may have been thrown down. The solution generally used contains about one and one-half pounds of free cyanide per ton of solution. This is raised to ten pounds of cyanide for cleaning copper out of the boxes. It is useless, however, to dissolve the copper unless there is gold or silver to take its place. With a constant strength of cyanide, accumulation of copper will cause this metal to be deposited. One precaution which should be taken is to keep the quantity of zinc used for precipitation as small as possible. In the Betty process, zinc shavings are dipped in a solution of lead acetate. The spongy coating of lead formed protects the zinc from deposits of copper, and assists in the precipitation of gold and silver. The dipping solution is made of ten per cent solution of lead salt. In handling the zinc, this should not be left standing in the air while moist, as oxidation sets in immediately. The author is at present precipitating, with a solution carrying forth forty-five pounds of copper per ton, $4 in gold and one and one-half ounces of silver. The precipitating boxes contain three compartments eighteen inches square. The rate of flow is three-quarters of a ton per hour through each. The precipitation of silver is always complete, and the solution, after leaving the box, is seldom over twenty cents. A method is given for determining the amount of copper in the solution. —*Abstracted from the Mining and Scientific Press (San Francisco), January 24.*

***Edison and Jungner Cells.***

This article gives a brief comparison, by Mr. W. Hibbert, of the Jungner alkaline oxide cell. Jungner's search for an accumulator which would avoid the difficulties of acid lead cells became successful in 1897-1899, and in the last-named year he patented an accumulator using a potash solution as the electrolyte, and plates of powdered metal or oxides of such metals as were insoluble in the liquid and gave sufficient electromotive force. His later patents have been on improvements in details only. The oxides first specified were those of cadmium, copper, iron, manganese, silver and nickel. His patents were bought by a Scandinavian company in 1900, and some months later an automobile furnished with these cells was tried under official conditions. The total weight of this, including batteries and passengers, was 1,162 pounds. The battery itself weighed 638 pounds. On wet and muddy roads about eighty-seven miles were covered with one charge. A final test, made on the streets of Stockholm, resulted in a run of ninety-two miles on one charge, the potential of the cells not falling below the nominal; and at the end of the run the carriage was traveling at a speed of sixteen and one-half miles per hour. The battery used for these tests contained electrodes of powdered oxides of nickel and silver, separated by asbestos paper. The latter was found to need renewal after every 120 charges, and the metals were too expensive. Jungner therefore returned to nickel peroxide as the positive, and powdered iron as the negative. This was done in the fall of 1900, and it is claimed to give priority over Edison's patent of February 5, 1901.—*Abstracted from the Electrical Review (London), January 30.*

***Movable Coil Galvanometers.***

The movable coil galvanometer has come into wide use because the rapid spread of electric railways has made necessary a type of instrument not affected by railway currents, as is true for this instrument. Many precautions are necessary in using this, which are not generally known to physicists. The effect of the resistance in the circuit upon the sensitiveness is a very puzzling matter. If the sensitiveness is reduced by inserting a high resistance, the damping is inconveniently reduced. The expedient of shunting produces usually excessive damping. In this article Herr W. Volkmann gives some useful hints as to combining shunting and resistance in a generally effective manner. Every change of sensitiveness should not change the damping and resistance in the circuit. To accomplish this a combined shunt and resistance box is constructed which secures the desired end. The box contains three combined circuits which may be plugged in so as to make different combinations, and gives eight adjustments which enable the sensitiveness to be varied from 1 to 0.0000001.—*Abstracted from the Annalen der Physik (Leipsic), January.*

## BOOK REVIEWS.

**"Principles of Inorganic Chemistry." Harry C. Jones. New York. The Macmillan Company. Cloth. 521 pages. 6 by 9 inches. Illustrated. Supplied by the ELECTRICAL REVIEW at $4.00.**

Inorganic chemistry has undergone marked developments in the last few years, so that it has seemed desirable to the author of this book to present a new treatise on the subject which would embody some of the new conceptions of physical chemistry. The book, therefore, contains a discussion of the theory of electrolytic dissociation, the law of mass action, the phase rule, and Faraday's law as the basis of chemical valence. The general arrangement of the book is not essentially different from that commonly adopted in treatises of this kind, the various groups of elements being taken up in their proper order. Chapter eight considers osmotic pressure and the theory of electrolytic dissociation as held by the German school.

## *Wireless Telegraphy in War.*

The telegraph battalion at Berbera, on the Somali coast, Africa, will keep the British columns, as they advance against the Mullah, in touch with the vessels anchored at Verbera, by means of wireless telegraphy.

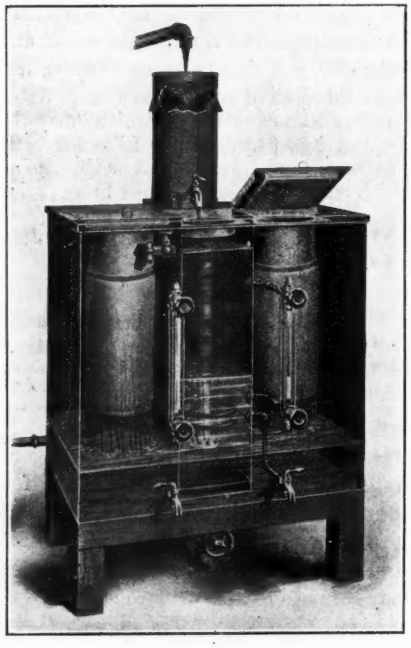
# INDUSTRIAL SECTION.

*ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.*

## *An Oil-Filtering System.*

In the system illustrated herewith the oil is fed to the several oil cups by gravity from the elevated reservoir, and after passing through the bearings is carried in piping to the filter, where it is purified and returned by the pump to the storage tank above. The third pipe carries any surplus back to the filter and prevents overflow. The supply of oil is thus continuous and uniform.

In the operation of the filter illustrated, the impure oil entering the auxiliary tank on top of the main body is drained through a removable screen located therein, and then passes out through the spigot at the bottom into a funnel suspended in the centre opening of the



OIL-FILTERING APPARATUS.

machine, and provided at the top with a screen, and at the lower end with a perforated conical foot closed at the bottom by a screw cap.

Surrounding this funnel is a rectangular compartment having an inclined bottom supplied with a drain outlet controlled by a valve. This chamber is partially filled with water kept at a moderate temperature by means of a steam coil entering from the back.

The waste oil descending the funnel tube is discharged below the surface of the water in an upward direction, thus leaving the sediment at the bottom of the chamber undisturbed.

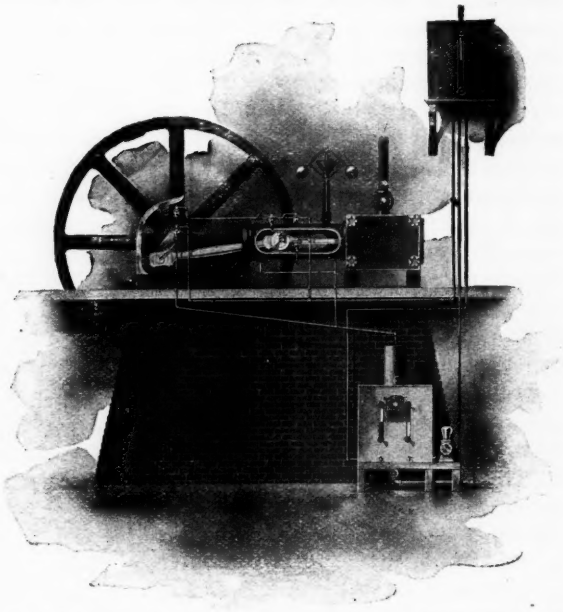
By the continued action of the heat the oil becomes thinned, and all the water and heavy impurities are rapidly separated from it by gravity, the former being automatically carried off by an overflow pipe at the back; and the latter, accumulating at the bottom of the chamber, are flushed occasionally through the drain connection.

The constant admission of oil to the separating chamber eventually causes it to reach the level of the outlets located near the top, and flow into the adjacent filtering cylinders, and from them into the main or storage chamber.

These cylinders are formed of a solid metal neck and bottom, with a section of open wire mesh between, and are suspended by loosely fitting flanges from supports at the top of the surrounding casing. Several layers of specially prepared cloth are wrapped around the cylinders and secured in position by stout cords tied above and below the beads formed in the solid metal.

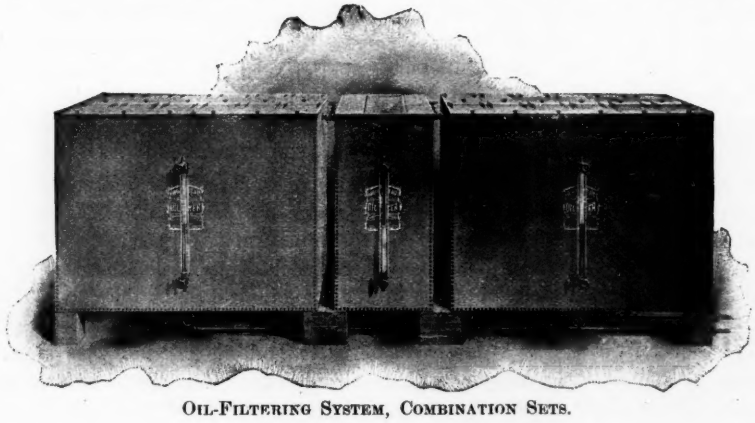
This cylindrical formation of the filtering medium presents such an extensive surface to the enclosed oil that its slow progress through the dense material is counterbalanced by the volume treated, and rapid flow results. In its passage through the body of cloth, the oil is entirely freed from impurity not previously eliminated by gravity, and is thus prepared for continued use.

The main structure of the apparatus is substantially formed of extra heavy galvanized sheet steel, riveted at the top to a stout wrought-iron frame. The seams throughout are lapped, riveted and brazed, and all openings for outlets are reenforced by riveted castings. The gauges, spigots and valves are finished in brass, and are attached to the casing by clamps and bosses.



OIL-FILTERING APPARATUS, RESERVOIR AND CONNECTIONS TO ENGINE.

When the filter is to be cleaned, the spigot over the central opening is closed and the auxiliary tank turned partly around in its retaining collar. One of the cylinders is then detached from its inlet pipe after the valve is closed, and lifted out and its contents emptied into the funnel. It is next inverted in the central opening, the cords removed, and



OIL-FILTERING SYSTEM, COMBINATION SETS.

the cloth unwrapped by the rotation of the cylinder in its flange. A clean cloth carried in the pocket under the lid is wound on in a reverse manner and fastened with the cords, the cylinder then being replaced and the valve opened.

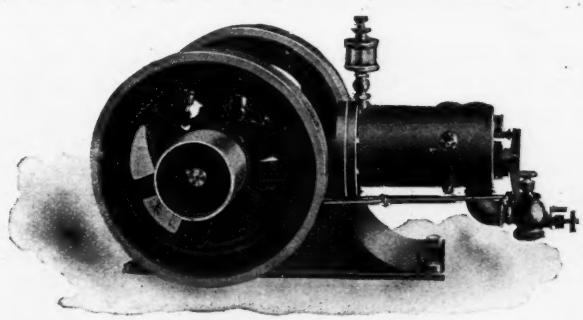
In equipping power stations of large size, the outlets are so arranged that a number of machines may be operated as one, and additional units attached as required, without disarranging the equipment. As may be seen from the illustration, the bottom outlets are connected to a common drain, to which is also attached a pipe to carry away the excess water discharged from the separating chamber by the overflow pipe. A horizontal equalizer pipe at the top of the combination provides a means for the automatic distribution of the oil to other units when any one is overworked.

This apparatus is designated as the White Star Filtering System, and is manufactured by the Pittsburg Gage and Supply Company, Pittsburg, Pa.

### *A Stationary Gasoline Engine.*

The accompanying illustration shows a new one-half-horse-power gasoline engine of the four-cycle type. This engine develops one-half horse-power at 500 revolutions per minute, and is stated to have, on test, run eight sixteen-candle-power incandescent lamps at 600 revolutions per minute. The engine may be run on either gasoline or illuminating gas with very little vibration, and an efficient muffler reduces the noise of exhaust to a minimum.

The cylinder is made of cast iron, thoroughly water-jacketed, and firmly bolted to the base. The cylinder-head contains the valves, and is also water-jacketed. The bearings are cast on the base, and are parted on an angle of forty-five degrees.



STATIONARY GASOLINE ENGINE.

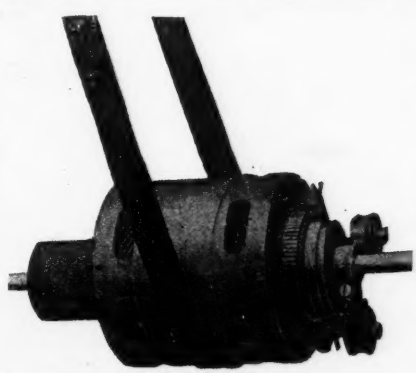
The crank-shaft is of steel, drop forged, and the connecting rod is of bronze, the piston and ring being of cast iron. Two heavy balance wheels are employed, one of which carries the governor, and the other a belt drum. Ignition is by electric spark, operated by the piston.

The dimensions are as follows: Cylinder, two and one-half inches bore, three and one-half inches stroke; crank-shaft, one inch diameter; crank-pin, one inch diameter; piston-pin, five-eighths inch diameter; balance-wheels, twelve inches diameter; floor space, twenty-one inches length, seventeen inches width, twelve and one-half inches high; the whole machine weighing 125 pounds.

This engine is manufactured by the Lowell Model Company, Lowell, Mass. This company also furnishes castings and complete gasoline motors for launches, automobiles and stationary purposes.

### *A Motor with External Armature.*

The accompanying illustration represents a new type of motor brought out by Mavor & Coulson, Limited (England). The peculiarity of this motor is the arrangement of the armature and field, the latter being internal. Although this idea is not new, heretofore some difficulty has been experienced in carrying it into practice, one of these arising from the oil thrown out by centrifugal force on the armature windings. The armature disc stampings are similar in form to the stampings of the stator of a polyphase motor, the windings being inserted radially from within. The magnet is a cross-shaped steel casting, with the wire wound on two limbs and two consequent poles. The coils are held in place by pole shoes attached to the magnet after the coils are in place. The magnet is mounted on a hollow shaft, through which the conductors for the field windings are carried. The external armature is hung on this shaft, with a running bushing bearing at each end. The advantages of this general arrangement of the machine are the greater radiating surface of the armature and the small weight of the field. The armature itself is said to be not materially heavier than an ordinary armature of the same power running at the same speed. This machine was specially designed for driving propeller fans, the blade being attached directly to the periphery of the armature. It has also been adapted to other places where lightness and ease in fixing are important factors. Tests of a one-half-horse-power motor of this type show an efficiency of from sixty-two to sixty-four per cent. The external dimensions of the armature of this motor are thirteen inches by ten and one-quarter inches.



MOTOR WITH REVOLVING ARMATURE.

### *Intercommunicating Telephone Systems.*

The many demands for an intercommunicating system that would give good satisfaction led the Atwater Kent Manufacturing Works, of Philadelphia, Pa., soon after the Monoplex instruments, made by this company, went on the market, to give the matter its attention. A careful study of the requirements of systems for various uses was made, and the systems developed by installing them in a large number of places where they would be given a severe test for reliability and convenience. The Monoplex instruments, used on these systems, are simple in construction, and the systems are designed so that they are easy to install.

FIG. 1.—MONOPLEX TELEPHONE.

Fig. 1 is an illustration of the Monoplex instrument, and Figs. 2, 3 and 4 are diagrams of circuits designed for use with these instruments.

Fig. 2 shows an all-around intercommunicating and selective ringing system. The instruments have no switches and are automatic in operation. A feature with this switchless type of instrument is in the calling operation. All that is nec-

essary is to press the button beside the name of the station to be called.

The number of wires needed on this system is three, plus the number of instruments, so that a system of five sta-

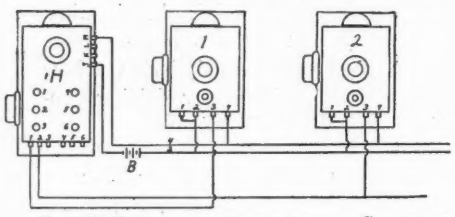


FIG. 2.—INTERCOMMUNICATING AND SELECTIVE RINGING.

tions would require three plus five, or eight, wires. Only one central battery is needed for both ringing and talking circuits, and, for the ordinary system, three dry cells or four wet cells are sufficient.

Fig. 3 shows this company's "Universal" intercommunicating system, non-selective ringing, but thoroughly intercommunicating. This requires four wires, and a single push-button at each instrument rings all of the bells on the system.

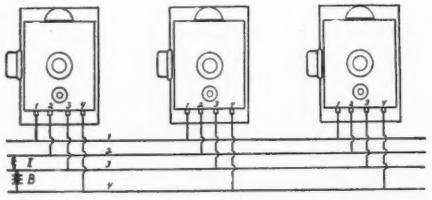


FIG. 3.—INTERCOMMUNICATING AND NON-SELECTIVE RINGING.

A central battery of two or three cells is required for this system.

Fig. 4 shows a selective ringing, non-intercommunicating system. This is designed for service where there is a central and several outlying stations. Each station can call up and talk to central, and central can call up individuals, but the stations can not call up and talk to each other. The number of wires required is

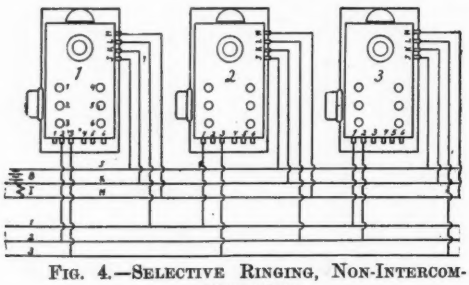


FIG. 4.—SELECTIVE RINGING, NON-INTERCOMMUNICATING.

two, plus the number of outlying stations. Thus a system consisting of a central and four outlying stations would need six wires. If the stations were located in opposite directions, three wires are connected to each. The battery is centrally located, and no impedance coil is used.

## *An Electropneumatic System of Railway Motor Control.*

As was noted recently in these columns, the Brooklyn Elevated Railway Company has placed an order for 210 multiple train-control equipments, which will be used for the operation of electrically propelled trains on its lines. All of the steam locomotives now in use will be, in a short time, replaced, and trains operated by this system, which involves the use of compressed air for moving the current-controlling apparatus, electromagnetic valves governing the admission of air to the controlling cylinders, and low-voltage electric circuits running from car to car for controlling the action of the magnet valves. The connections for the low-voltage circuits are the only ones which have to be established between the cars of the train, no air connections being required outside of the ordinary brake-hose.

The accompanying illustrations show, in Fig. 1, the operating head; Fig. 2, the multiple control switch closed; Fig. 3, the circuit-breaker; Fig. 4, the car connectors.

The complete standard-controlling equipment for each car consists of one controller with operating head, two motormen's multiple-control switches, one railway-type circuit-breaker, one set of seven-point connectors, and fourteen cells of storage battery.

The controller is of the series parallel type, similar in design to the ordinary form of hand control. This consists essentially of two drums which revolve in bearings mounted upon a substantial cast-iron frame, and stationary contact fingers which make contact with points on the revolving drum. The operating head, which is shown in Fig. 1, consists of an operating cylinder, *a*; a release cylinder, *b*; two reverse cylinders, EE; a repeating switch, *d*; a limit switch, *e*; four magnetic valves, $f^1$, $f^2$, $f^3$, $f^5$, and two safety switches, *g*, *h*.

The operating cylinder is employed to throw the controller on notch by notch, and accomplishes this by means of two pawls which are mounted upon the end of the piston rod, and which engage two ratchet plates fastened to the end of the

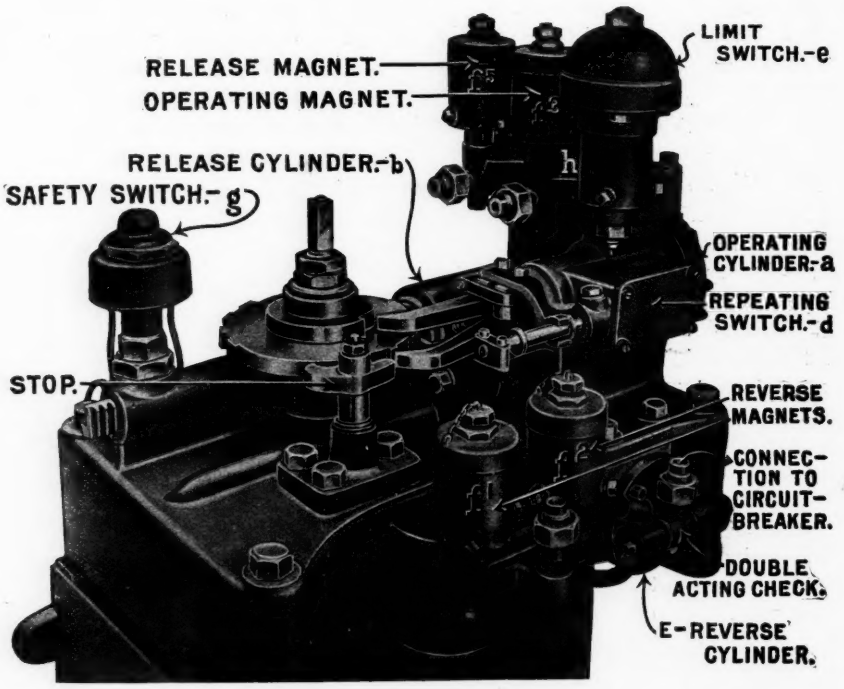



FIG. 1.—THE OPERATING HEAD OF THE ELECTROPNEUMATIC SYSTEM OF RAILWAY MOTOR CONTROL.

shaft of the main drum of the controller. Two ratchet plates are employed, so that with a fixed stroke of piston the control drum may move through a greater or less angle, to correspond with the position of the drum contacts. The release cylinder is provided for the purpose of throwing the controller to the off position. A rack cut upon the piston rod of this cylinder engages with a pinion keyed to the shaft of the main drum of the controller directly underneath the ratchet plates.

The reverse cylinders are used merely to throw the reverse switch to the "back" or "ahead" positions, and they accomplish this by means of a rack and pinion construction similar to that employed for the

release cylinder. The four magnet valves are employed to open or close the ports admitting air to the various cylinders.

The repeating switch is provided for the purpose of producing automatic operation of the controller while the car is accelerating. The action of this switch is regulated by the limit switch, *e*, which consists of a magnet connected across the field of one of the motors, and arranged to short-circuit the repeating switch, thus stopping the advance of the controller when the current taken by the motor exceeds a predetermined limit.

The safety switch, *g*, which is so arranged as to be opened at all times by a spring, except when the controller is at the off position, is provided to prevent the reverse switch from being thrown, or the circuit-breaker from being put in unless the controller is in the off position.

The switch, *h*, is provided so that when

FIG. 2.—MULTIPLE-CONTROL SWITCH.

air is admitted to the release cylinder the circuit of the operating magnet is opened, thus preventing all chance of the operating and release cylinders working against each other.

The circuit-breaker is of the standard railway type, provided with a special front on which are mounted the pneumatic operating devices. This is shown in Fig. 3, and the pneumatic devices provide a means by which the motorman may open or close the circuit-breaker. The two multiple-control switches are placed one at each end of the car, and by means of one on the front of the leading car, the motorman directs the action of the controllers on all of the motor cars in the train. The multiple-control switch is shown in Fig. 2, and consists essentially of a skeleton brass drum mounted upon a shaft, and insulated therefrom, and stationary contact fingers making contact

FIG. 3.—CIRCUIT-BREAKER.

with points upon the drum. This switch controls only the low-voltage battery circuits which operate the magnet valves.

The low-voltage battery connectors between the several cars of the train are established by means of the seven-point connectors shown in Fig. 4. These connectors consist of plugs and sockets. The sockets are secured to the cars beneath the platform, and a pair of plugs connected by a short length of cable is employed to connect between the sockets on adjacent cars.

This system has been developed by Mr. George Westinghouse, and is designed and built by the Westinghouse Air Brake Company, Pittsburg. The arrangement allows the control system to be isolated from the main power circuit, making it independent of fluctuations in voltage due to changes in traffic. In this way the control circuit is also unaffected by momentary interruptions of current due to ice or sleet on the third rail. Fuses in the control circuit are eliminated, and the controlling apparatus is so located that the motorman may have convenient access to all parts of his compartment on the platform of the car. The system also permits the motorman to open instantaneously at will all cutouts or circuit-breakers on the train, and the controllers

FIG. 4.—CAR CONNECTORS.

are automatically turned off by the application of the automatic air-brakes. In this system both controllers and circuit-breakers are opened by the breaking in two of the train, this action being independent of, and in addition to, the effects obtained by the application of the air-brake train-line connection.

The Brooklyn elevated will equip all of its new cars with four motors each. The 150 cars now in use equipped with this system have each two motors. The trains on the road are made up of five or six cars, two or three of which are usually motor cars. By the use of this system it is possible to operate cars individually, as on ordinary trolley roads, or make them up into trains of any length.

## *Dinner to Mr. W. D. Sargent.*

Mr. William D. Sargent, vice-president of the New York & New Jersey Telephone Company, was married on Wednesday of this week at the home of the bride, Miss Mary F. Kooser, at Somerset, Pa. A number of New York friends of Mr. Sargent was present at the ceremony, traveling in a special car from this city. On Saturday, February 14, a number of the electrical friends and associates of Mr. Sargent tendered him a bachelor dinner at the Hamilton Club, in Brooklyn. The occasion was a most delightful one, and was presided over by Mr. Charles F. Cutler, president of the New York & New Jersey Telephone Company, Mr. Henry Sanger Snow, treasurer of the same company, acting as toastmaster. A number of informal little speeches was made. The menu was handsomely got up, and contained the following quotations from Shakespeare as of timely application to each person named:

GUEST.

WILLIAM DUNLAP SARGENT.
"When I said I would die a Bachelor, I did not think I should live 'til I were married."—*Much Ado About Nothing.*

HOSTS.

CHARLES R. BANGS.
"An inviting eye; and yet methinks right modest."—*Othello.*

U. N. BETHELL.
"The gentleman is learned and a most rare speaker."—*Henry VIII.*

EDWIN M. BROOKS.
"You are the fount that makes small brooks to flow."—*Henry VI.*

ALEXANDER CAMERON.
"Why may not that be the skull of a lawyer."—*Hamlet.*

WILLARD L. CANDEE.
"But I will eat and drink and sleep as soft as captain shall."—*All's Well That Ends Well.*

FRANK W. CONN.
"Then hadst thou had an excellent head of hair."—*Twelfth Night.*

CHARLES F. CUTLER.
"A wise fellow, and, which is more, an officer."—*Much Ado About Nothing.*

BANCROFT GHERARDI, JR.
"A most lovely, gentleman-like man."—*Midsummer Night's Dream.*

EDWARD J. HALL.
"Be checked for silence, but never taxed for speech."—*All's Well That Ends Well.*

J. LEWIS HAMAR.
"A kind of auditor; one that had abundance of charge, too, God knows what."—*Henry IV.*

WALDRON HOPPINS.
"What damned minutes tells he o'er?"—*Othello.*

HARRY G. McCULLY.
"But lusty, young and cheerly drawing breath."—*Richard II.*

EDWARD P. MEANY.
"A gentleman of excellent breeding, admirable discourse."—*Merry Wives of Windsor.*

JOHN C. REILLY.
"With what a majesty he bears himself."—*Henry VI.*

ALBERT L. SALT.
"Love's company, is free of speech."—*Othello.*

HENRY SANGER SNOW.
"I'll end my exhortation after dinner."—*Merchant of Venice.*

HIRAM F. STEVENS.
"This fellow might be, in 's time, a great buyer."—*Henry V.*

HARRY B. THAYER.
"His hum is a battery."—*Coriolanus.*

LOUIS E. TIESTE.
"I know my physic will work with him."—*Twelfth Night.*"

# CURRENT ELECTRICAL NEWS

LONG ELECTRIC ROAD IN MISSOURI—A charter has been issued to the Central Missouri Electric Railroad, capitalized at $4,000,000. This company is to build a road to extend from Brookfield to Glasgow and thence to St. Louis, Mo., a distance of 104 miles. It is stated that Colonel W. N. Chase, of New York, is the principal financier of the road, and the line is to be completed in time for the opening of the Louisiana Purchase Exposition.

EVERETT-MOORE PROPERTIES—Negotiations are said to have been completed for the formation of a holding company to take over the Detroit United Company, the Lake Shore Electric Railway Company, and the Detroit & Toledo Short Line. For the present the Detroit, Ypsilanti, Ann Arbor & Jackson Railway will not be included in the deal. At present the Lake Shore Electric Railway Company is undergoing a process of reorganization, in furtherance of which the directors have decided on an issue of $4,000,000 mortgage bonds. An additional issue of $4,000,000 five per cent preferred stock is also in contemplation, which will bring the total up to $6,500,000. With the elimination of the traction companies it is stated that Henry A. Everett will be free to proceed with the reorganization of the Ohio telephone properties.

GERMAN ELECTRICAL TRUST—The Siemens & Halske Company and the Schuckert Electric Company have decided to unite, subject to the approval of the stockholders. The recent amalgamation of the Allgemeine and Union companies has hastened the merging of the former companies. The Siemens & Halske Company has a capital of $13,625,000, and $7,500,000 in debentures. The Schuckert company has a capital of $10,500,000, plus $7,000,000 of the Continental Financing Company. The Schuckert company has lately recovered from a complicated financial difficulty. The new corporation is a limited liability company with a capital of $25,500,000, and will be known as the Siemens-Schuckert Works. It is understood that the old companies share about equally in supplying the capital. All the shares of the subcompanies will be excluded, as well as those of the Siemens Dynamo Works at Charlottenburg, and the cable works at West End. The combination is announced to go into effect in April.

PRODUCTION OF ZINC BY ELECTRICITY IN SWEDEN—According to current reports there is every probability that works will be established in Sweden for the electrolytic production of zinc. Consul R. S. S. Berg, writing from Gothenburg, quotes the following translation of an article published by a local newspaper: "Experts in metallurgy have for some time discussed the report that Dr. De Laval, after extensive experiments, has been able to produce zinc from zinc ore by electricity at the Factory Onan, belonging to Trollhättans Elektriska Aktiebolag, Trollhättan. It is reported that the manufacture of carbide at Onan has been discontinued and the production of zinc by Dr. De Laval's method adopted. An expert states: 'Dr. De Laval has for several years worked on the problem of producing zinc by electricity from lead-sulphur-zinc ores. He was probably led to this by his experiments in trying to separate iron from ores by electricity. An examining board has reported favorably on the method, and the result has been the organization of a company to exploit the invention and the ore deposits at Saxberget, near Ludvika. The minimum capital—$26,800—has already been paid, and the company will start operations as soon as circumstances will allow.'"

NEW YORK CENTRAL RAILROAD'S TERMINAL BILL—Assemblyman Bedell, of the Assembly Committee on Railroads, has introduced a bill at Albany which provides for the $25,000,000 terminal improvement plan of the New York Central Railroad in New York city. This bill authorizes the Board of Estimate and Apportionment to make to the railroad company the necessary grants for the depression of its tracks. The company is to prepare plans for the building of viaducts and bear all expenses for their construction, excepting the Park avenue viaduct, in excess of $600,000. The city is to pay to the company $600,000 as its contribution to the cost of these improvements, and the railroad is to pay to the city $25,000 annually for the use of the subsurface of the streets. The use of steam below the Harlem River is forbidden. The company is required to substitute for steam electricity "or any motive power other than steam which does not involve combustion in the motors themselves." In explanation of this latter clause it is announced that it is the intention of the company to use electricity, and its present plans contemplate the use of this motive power for a considerable distance beyond the city limits, both on the Hudson River and on the Harlem Railroad. A time limit of five years has been fixed, for the reason that very great changes contemplated must be carried on without interrupting the ordinary business of the road.

### *TELEPHONE AND TELEGRAPH.*

NUNDA, N. Y.—The Business Men's Telephone Company has been organized to succeed the Nunda Telephone Company.

CLIFTON, KAN.—G. M. Stratton has been granted a franchise by the city of Clay Center to build a telephone system there.

LOUISVILLE, KY.—The Cumberland Telegraph Company is preparing to spend $1,000,000 on improvements and new lines in this city.

ELMIRA, N. Y.—The American Telegraph and Telephone Company has completed its new long-distance line from Troy, N. Y., to this place.

JOHNSTOWN, PA.—The Bell company is making substantial improvements to its system here, with a view to giving its patrons more rapid long-distance connections.

CORTLAND, N. Y.—The Bell Telephone Company is said to be preparing to install a new and up-to-date system in this city, with a view of making a bid for local business.

BOONE, IOWA—The Boone Telephone Company is said to be considering the matter of consolidating with the Des Moines Mutual and other toll lines, and action of this character is expected.

DAVENPORT, IOWA—The Wettstein Telephone Company and the Electric Light and Telephone Company, of La Porte City, have merged under the title of the La Porte Public Utility Company.

FLEMINGTON, PA.—The board of village trustees has granted a franchise to the Farmers and Merchants' Telegraph and Telephone Company, allowing the company the right to construct a line in this town.

AURORA, ILL.—The Interstate Telephone Company has begun work building its toll line from Sterling to Aurora. In a few weeks the work of running a main line to Chicago and another to Cedar Rapids, Iowa, and one to Decatur, will be commenced.

LA CROSSE, WIS.—Articles of incorporation of the Barre Mills Telephone Company were filed with the Secretary of State recently. The company was incorporated for the purpose of building a telephone line in the townships of Barre and Hamilton, to connect with local and through lines.

ALBANY, N. Y.—The Ontario Telephone Company, of Onondaga and Oswego counties, has filed with the Secretary of State an amended certificate of incorporation under which it will operate in Fulton, Oswego, Seriba, New Haven, Mexico, Richland, Sandy Creek, Volney, Schroeppel, Hannibal and Granby, Oswego County, and Lysander, Clay, Salma and Liverpool, Onondaga County. The capital stock of the company has been increased to $40,000, and it is planned to extend the line from Oswego to Pulaski.

ROME, N. Y.—At the annual meeting of the Rome Home Telephone Company, held recently, the following officers were elected: President, Fred M. Shelley; vice-president, John S. Wardwell; treasurer, John E. Mason; secretary and manager, Daniel M. Hall. A line is being constructed between Buffalo and Albany, and all the places along that line will be connected with the local system of the company. Extensive improvements are also to be made as soon as the Rome system can be connected with the Utica system.

## ELECTRICAL SECURITIES.

Foreign affairs have played an important part in the shaping of the condition in which the market found itself at the end of the past week. There is little likelihood of any further unsettlement due to the Venezuelan affair; but other important interests which have had a slightly straining effect on diplomatic arrangements are in force, and until these are cleared up there will be more or less apprehension felt in commercial centres.

Considerable satisfaction is felt in the continued strong showing made by the industries, particularly for the railroads and the iron and steel trade. The heavy domestic consumption of iron and steel last year is shown by exports valued at $4,642,539 less than in 1901, and $31,714,444 less than in 1900, while imports increased $21,073,811 over the previous year, and about the same amount as compared with 1900. In place of the net decreases of last November for railroad earnings, there has been a slow but steady improvement during December and January, and the advancing months of the year show the net returns to be increasingly advanced.

ELECTRICAL SECURITIES FOR THE WEEK ENDING FEBRUARY 14.

| *New York:* | *Closing.* |
|---|---|
| Brooklyn Rapid Transit | 69¼ |
| Consolidated Gas | 217 |
| General Electric | 202⅜ |
| Kings County Electric | 228 |
| Manhattan Elevated | 144⅜ |
| Metropolitan Street Railway | 138 |
| New York & New Jersey Telephone | 162½ |
| Westinghouse Manufacturing Company | 218 |

The Brooklyn Rapid Transit Company has entered into a contract with the Edison Electric Illuminating Company, by which it will receive additional power to operate elevated trains on all roads, except in the Ridgewood division, by electricity instead of steam.

A special meeting of the stockholders of the Commercial Cable Company will be held March 2, 1903, at 4 o'clock P. M., at the office of said company, No. 253 Broadway, New York city, for the purpose of voting upon a proposition to increase the capital stock of the company from $15,000,000 to $25,000,000, and also for considering and determining the purposes and mode of issue of said increased capital stock. The transfer books will be closed on the afternoon of February 20, and reopened on the morning of March 3, 1903. The annual meeting of the stockholders of the company will be held the same day at 2 o'clock P. M.

| *Boston:* | *Closing.* |
|---|---|
| American Telephone and Telegraph | 165 |
| Edison Electric Illuminating | 291 |
| Massachusetts Electric | 92¾ |
| New England Telephone | 136 |
| Western Telephone & Telegraph preferred | 98¼ |

| *Philadelphia:* | *Closing.* |
|---|---|
| Electric Company of America | 9½ |
| Electric Storage Battery common | 79 |
| Philadelphia Electric | 8 1/16 |
| Union Traction | 47 |
| United Gas Improvement | 113 |

| *Chicago:* | *Closing.* |
|---|---|
| Chicago Edison Light | 160 |
| Chicago Telephone | 156 |
| Metropolitan Elevated preferred | 87 |
| National Carbon common | 24 |
| National Carbon preferred | 98 |
| Union Traction common | 10¼ |
| Union Traction preferred | 45 |

Judge Windes, on behalf of the Appellate Court, affirms the order entered in Judge Tuley's court a year ago, granting a temporary injunction to restrain the Chicago Telephone Company from charging more than its franchise rate of $125 a year for its business service. The restraining order also enjoined the company from removing 4,000 business telephones from the complainants' places of business and from cutting off their service.

## NEW INCORPORATIONS.

DOVER, DEL.—The New York Mines Company. $40,000.

ST. JOSEPH, MO.—The Ord Telephone Company. $10,000.

FRANKFORT, KY.—The Camp Ground Telephone Company. $6,000.

DES MOINES, IOWA—Bedford Light, Heat and Power Company. $20,000.

DES MOINES, IOWA—Union Electric Construction Company. Increased to $5,000,000.

LA CROSSE, WIS.—La Crosse Telephone Company. Increased from $50,000 to $100,000.

AUGUSTA, ME.—The Androscoggin Lake Telephone and Telegraph Company. $5,000.

COLUMBUS, OHIO—Kenton Telephone Company. Increased from $50,000 to $100,000.

DAYTON, OHIO—The Mechanicsburg Telephone Company. Increased from $20,000 to $35,000.

DES MOINES, IOWA—Farmers' Mutual Telephone Company. $5,000. Incorporators: Evan Swenson and H. D. Webb.

NEW MARKET, MINN.—Star Telephone Company. $50,000. Incorporators: P. J. Welter, J. A. Sanford and Henry Sprain.

LITTLE ROCK, ARK.—The Bald Knob Telephone Company. $5,000. Incorporators: E. R. Wynn, George Dickey, L. G. Wynn.

AUSTIN, TEX.—Amarillo Telephone Company. $10,000. Incorporators: D. C. Stegman, R. L. Stringfellow and J. L. Smith.

TRENTON, N. J.—Villiant Company. $500,000. Incorporators: Benoni Lockwood, Jr., William S. Woodhull, Henry A. Bingham.

DENVER, COL.—Sheridan Electric Light and Power Company. $75,000. Incorporators: Thomas B. Whitted, George F. Christie, Charles K. Durbin.

BROWNWOOD, TEX.—Boysen Light and Power Company. $30,000. Incorporators: S. R. Goggin, B. S. Boysen, Henry Ford and G. N. Harrison.

INDIANAPOLIS, IND.—People's Telephone Association of Indiana. $10,000. Directors: Bayard L. Kilgorer, Ernest W. Swarthout and George M. Roberts.

JERSEY CITY, N. J.—Bozeman Electric Light and Traction Company. $300,000. Incorporators: Charles E. Hendrickson, John M. Quinn and Joy Noble Emley.

AUGUSTA, ME.—The International Telephone and Telegraph Company. $1,000,000. Incorporators: Raymond R. Gilman, Melroes, Mass., and Charles R. Groves, Boston.

CAMDEN, N. J.—Shreveport & Suburban Traction Company. $100,000. Incorporators: John R. Miller, William S. Lambert, Herman Hedberg, Austin Miller, Cecil L. Bland.

MONROE, IND.—The Wabash Home Telephone Company. $10,000. Directors: Joseph J. Joice, F. M. Goodsell, Ed. C. Von Tress, James Bonewitz, Ed. P. Blann and J. Monroe Golmon.

ALBANY, N. Y.—The Central Valley & Highland Mills Electric Light and Power Company. $140,000. Directors: W. H. Cowan, W. L. Dickerson, of Montgomery, and Charles Rivenberg, of Walden.

WATERLOO, IOWA—Commonwealth Telephone Company. $900,000. Incorporators: Rufus C. Dowes, Clarence B. Geist, A. G. Wheeler, H. C. Wood, A. E. Wilson, H. A. Wilkening and S. F. Harris.

INDIANAPOLIS, IND.—The Bedford Home Telephone Company. $75,000. Directors: Charles Laciz, C. H. Emery, W. A. Brown, John C. Monteith, Edmund B. Thornton, G. C. Dudley and John A. Hartman.

HARTFORD, CT.—The Eddy Electric Corporation. $150,000. Incorporators: M. E. Westover, G. E. Emmons, E. W. Rice, Jr., and Hindsill Parsons, of Schenectady, N. Y., and Walter C. Fish and J. A. Dalzell, of Lynn, Mass.

GUTHRIE, OKLA.—Ardmore Electric Light and Power Company. $40,000. Incorporators: William J. Lemp and A. Ruemmelli, of St. Louis, Mo.; H. E. Foster, of Ardmore, I. T.; Henry Braun and Paul Jundt, of Guthrie; John Wood and J. E. Everest, of Oklahoma city.

INDIANAPOLIS, IND.—The Daisy Telephone Company. $2,000. Incorporators: William H. Porter, W. E. Gray, Daniel M. Gray, Charles F. Gray, Benjamin F. Stalker, William Stone, William Rosenberger, Benjamin Schmidt, Charles Huber, W. B. Horsell, J. W. Durham, A. G. Gray.

## ELECTRIC RAILWAYS.

LA CROSSE, WIS.—An interurban street railway line is to be constructed between this city and Viroqua, a distance of fifty-three miles.

CHATTANOOGA, TENN.—The work of improving the Knoxville & Ohio road from Knoxville to Jellico will begin in a short while. The work will cost about $1,000,000.

PITTSBURG, PA.—Plans are being prepared for the construction of a trolley line from East Brady and Chicora to Butler. The scheme is backed by Butler, Chicora and East Brady capitalists.

COLUMBUS, OHIO—The Zanesville & Southern Railway Company, of Zanesville, increased its capital stock from $10,000 to $1,000,000 recently. It is believed that many improvements will be made to the system.

FLINT, MICH.—It is stated that $8,000,000 worth of the bonds of the Saginaw Suburban Electric Railway have been placed, and that contracts have been let for grading and building the road, the work to begin early next spring.

JERSEY CITY, N. J.—The Puget Sound Electric Railway Company has filed an amended certificate of incorporation here, fixing the capital stock at $4,500,000, of which $1,000,000 is six per cent non-cumulative preferred, and the balance common.

PHILADELPHIA, PA.—Articles of incorporation of the Baltimore & Belair Electric Railway have been filed with the Secretary of State. The capital stock is $500,000. The route will be either upon the Baltimore & Hartford or Baltimore & Jerusalem turnpike.

NEW YORK, N. Y.—The Florence Electric Street Railway Company, of Florida, has recorded a deed of $2,700,000. The Eastern Trust Company, of this city, is named as trustee. The purpose of the company is to build 125 miles of electric railway to connect cities and towns in the Arkansas Valley.

CHAMBERSBURG, PA.—At a meeting of the directors of the Chambersburg, Greencastle & Waynesboro Trolley Company held recently, it was decided to build the road next summer from Greencastle to Pen-Mar, a distance of fourteen miles. The capital stock will be increased from $120,000 to $300,000.

INDIANAPOLIS, IND.—The Indianapolis & Cincinnati Traction Company, with a capital of $1,500,000, has been incorporated by Charles L. Henry, W. L. Taylor, T. F. Rose, Ephraim Marsh, William M. Franzee, A. M. Johnson and James F. Fesler. The line in Indiana will run from Indianapolis to New Palestine, Morristown, Rushville, Connersville and Brookville.

LANSING, MICH.—Articles were filed to-day by the Michigan Shore & Eastern Railway with $1,000,000 capital. The line in Michigan runs from Bertrand Township, Berrien County, on the Indiana state line, to Kalamazoo, and it is the purpose of the new company to absorb the Benton Harbor, Coloma & Paw Paw Lake Tram Railway, and the South Haven & Eastern.

SANDUSKY, OHIO—The Findlay & Southern Electric Railway Company has disposed of its franchises and right of way for a line between Findlay and Columbus to a Chicago syndicate, which, it is said, will at once build the road. In payment of the valuable franchises and right of way, it is understood nearly $2,000,000 in stocks and bonds was turned over to the old company.

LOUISVILLE, KY.—The Louisville, Anchorage & Pewee Valley Electric Railway Company has filed amended articles, increasing its capital stock from $350,000 to $1,250,000. The amended articles also provide that the corporation shall have the right to extend its lines to Shelbyville, Frankfort and Eminence; also to a point on the Kentucky River in Henry County, and to Mount Eden from Shelbyville.

WABASH, IND.—It is said that the Wabash River Traction Company has sold its line from Wabash to Logansport to the Union Traction Company, of Indiana. The consideration is reported to be almost $1,000,000. The line was built from Wabash to Peru several years ago, and is now being extended to Logansport. When completed, the system will include thirty-four miles of road from Wabash to Logansport, and the Logansport city lines which were bought last year.

OMAHA, NEB.—The Omaha, Decatur & Northern Railway Company, with a capital of $1,000,000, has filed articles of incorporation with the Secretary of State. The company intends to build an electric railway through the counties of Douglas, Washington, Burt, Thurston and Dakota. The headquarters will be in Omaha. The incorporators are: C. E. Burlow, A. M. Anderson, E. H. Martin, H. D. Bryan, P. B. Gordon, W. R. Lewis, F. W. Bennett, F. E. McNutt, H. H. Bone and G. H. Pusse.

SARATOGA, N. Y.—The petition of the North River Railway Company to construct and operate a trolley system here has been favorably considered by the local authorities. The company also proposes to build branch lines to Schuylersville, twelve miles, and to Corinth, fourteen miles distant. The road, it is understood, will be run in connection with the Hudson Valley Railway, which has under its control almost 100 miles of trolley line in Saratoga, Warren and Washington counties.

ROANOKE, VA.—The Roanoke Railway and Electric Company, capitalized at $690,000, has been sold to Philadelphia capitalists, who take all of the $200,000 stock and a large block of the bonds. Twenty miles of track are included in the purchase. The new officers elected are: President, A. P. Apperson, Lynchburg, Va.; vice-president, Charles R. Miller, Philadelphia; secretary and treasurer, F. H. Shelton, Philadelphia; general manager, J. W. Hancock, Roanoke, Va.

BIRMINGHAM, ALA.—The Sheffield Company has been incorporated under the laws of New Jersey with a capitalization of $525,000. The new company will acquire the waterworks of Sheffield, the electric light franchise, and franchises for trolley lines to Tuscumbia and Florence. Colonel A. P. Andrews, of the Southern Railway, and J. C. Mayben are interested, as are also George Parsons, of New York; his brother, Charles Parsons, and Messrs. Goodby, Strong & Mortimer.

PITTSBURG, PA.—Pittsburg people, with capitalists from Toronto, Canada, have formed a company for the construction of a belt electric line through the Niagara peninsula. The proposed route is from Homer to Niagara-on-the-Lake, and thence to Queenstown, returning to Homer, in all a distance of thirty-two miles. The working capital of the company is $400,000, but will probably be increased. Work on the new line will be commenced July 1, and will probably be completed in two years.

MINEOLA, N. Y.—Two franchises over the country roads were granted the New York & Long Island Traction Company, formerly the Mineola, Hempstead & Freeport Traction Company, by the Nassau County board of supervisors at its recent meeting, one being along the Jericho turnpike in the town of North Hempstead, and the other to cross certain county roads in the town of Hempstead. The term of the franchises is for ninety-nine years, and the company must have the road in operation on or before July 1, 1904.

VERGENNES, VT.—The water power, real estate and industrial privileges of the Stevens estate, on the west side of Otter Creek in this city, have been acquired by John J. Flynn, of Burlington, for a sum above $100,000. Mr. Flynn will build an electric railroad into Vergennes, the power-house to be situated on the falls. Mr. Flynn is also interested in the Burlington Traction Company and in the St. Albans Street Railway. It is the purpose of the two companies to get together by a link from Essex Junction to St. Albans, a distance of twenty-four miles, paralleling the Central Vermont Railway from Burlingham to Swanton.

KITANNING, PA.—The Pittsburg & Allegheny Valley Railroad Company has closed the purchase of four big electric light plants and the franchise of the Leechburg & Apollo Street Railway Company. The plants are the following: Parnassus Electric Light and Power Company, the Leechburg Electric Light and Power Company, the New Kensington Electric Light and Heat Company, and the Apollo Light, Heat and Power Company. The street railway will be built from Apollo to Vandergrift, to Leechburg, to Braeburn, to Arnold, New Kensington and Parnassus, a distance of twenty miles, and will connect with the Pittsburg Railways Company. The company has a capital of $1,500,000, and is organized by John Q. Cochrane, Apollo, president; Dr. J. D. Orr, Leechburg, vice-president; J. J. Burke, Pittsburg, secretary.

### ELECTRIC LIGHTING.

JACKSON, MISS.—A stock company is being organized here for the erection of an electric light plant at a cost of $25,000.

GRAND RAPIDS, MICH.—The Lapeer Light and Power Company has been organized with a capital of $75,000, to include the Lapeer, Imlay City, Millville and Higley plants.

BOSTON, MASS.—The Edison Illuminating Company, of this city, has purchased from Arthur E. Appleyard the Natick Gas and Electric Company and the Framingham Electric Company.

SPRINGFIELD, MO.—The Springfield Lighting Company is planning to expend about $150,000 on improvements in Springfield during this year, and will virtually double the present capacity of the plant.

SPRING CITY, PA.—The authorities of the Schuylkill Valley Illuminating Company and the Montgomery & Chester Electric Railway Company have authorized the expenditure of $120,000 in betterments.

HACKENSACK, N. J.—Plans have been perfected by the Hudson River Line Company for the enlargement of its power-house at Edgewater, and the work will be commenced in the spring. The building will be made twice its present size.

BALTIMORE, MD.—At the annual meeting of the stockholders of the Maryland & Delaware Telephone and Telegraph Company, the expenditure of $150,000 for the building of new lines in Virginia was passed upon favorably.

NASHVILLE, TENN.—Michigan purchasers of the Caney Fork Falls water power, twelve miles east of Minnville, will erect a $1,000,000 power-house and dam with a capacity to transmit power to Nashville. The enterprise is said to have ample funds behind it.

### PERSONAL MENTION.

MR. W. D. HALL has been appointed electrical engineer of the Grand Trunk Railway System with headquarters in Montreal, Quebec.

MR. CHARLES WIRT, president of the Wirt Electric Company, Philadelphia, Pa., has been awarded the John Scott bronze medal on the recommendation of the Franklin Institute, for the invention of his rheostat.

MR. CHARLES DAY, of the firm of Dodge & Day, Philadelphia, Pa., read a paper before the last meeting of the Westinghouse Electric Club, of Pittsburg, on "Recent Developments in Machine Tool Equipment."

DR. J. B. WHITEHEAD, of the physical department of Johns Hopkins University, has received a liberal grant from the Carnegie Institution to carry forward a research in the theory of a magnetic field developed by Clerk Maxwell.

MR. JOHN STONE STONE, Boston, Mass., and Mr. Arthur E. Kennelly, of Harvard University, spent a few days in New York city last week. Mr. Stone is developing his wireless telegraph system, on which he has secured a number of important patents.

MR. GEORGE P. ROUX, Havana, Cuba, a prominent electrical engineer, has been spending a few days in America. Mr. Roux has done much engineering work in connection with electrical installations for sugar producing. He has also been identified with the construction and operation of several electric railway systems and electric lighting plants.

MR. GEORGE H. MORGANSTERN, formerly manager of the sales department of the Baird Manufacturing Company, of Chicago, is now with the Vought-Berger Company, La Crosse, Wis., in a similar capacity. Mr. Morganstern has recently completed a trip over the United States, which he made for the purpose of studying the telephone situation.

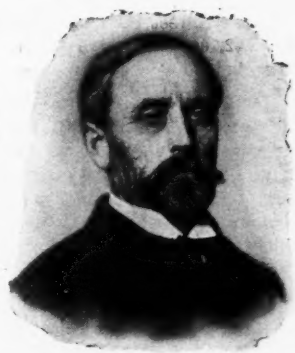
MR. CALEB R. BARNEY, the father of General C. W. Barney, a pioneer telephone man of this city, died at his residence, Providence, R. I., on the 4th instant, at the advanced age of eighty-seven years. He had enjoyed fairly good health for a person of his years until a short time before his last illness. He was the last survivor of seventeen brothers and sisters, all of whom lived to a good old age.

DR. HARRY C. JONES, assistant professor of physical chemistry at Johns Hopkins University, has been awarded a grant of $1,000 from the Carnegie Institution. This is for an assistant in his researches in new physical chemistry as it is studied in America. Frederick Hutton Getman, of Stamford, Ct., received the appointment. His doctoral dissertation deals with an important problem in physical chemistry.

MR. A. M. MORSE, who for the past six years was manager of the Chicago office of the Atlas Engine Works, has left this company and incorporated his business under the name of the Morse Power Company. He will conduct a joint sales agency for the sale of high-class engines, boilers and other station equipment, retaining the same office suite which he has been occupying at 1,102 Marquette Building.

MR. J. R. BIBBINS, of the Westinghouse Companies' publishing department, New York city, delivered an address at the last annual banquet of the New York Physics Club upon the subject of "Recent Developments and Use of Electric Power." Mr. Bibbins took up briefly the conditions leading up to and the present trend of modern engineering, as well as the more recent inventions which had been greeted with more or less prominence.

MR. ARTHUR WILLIAMS, the well-known electric light engineer, of New York city, who has been appointed by President Ferguson to report on decorative lighting at the coming convention of the National Electric Light Association, has sent out a letter to all the active members, asking them to send him designs of the display lighting installed by them. Mr. Williams will no doubt present a very complete report, which will add very greatly to the value of the programme of the coming convention.



COLONEL HENRY GOSLEE PROUT.

COLONEL HENRY GOSLEE PROUT, formerly editor-in-chief of the *Railroad Gazette*, has been appointed first vice-president and general manager of the Union Switch and Signal Company, of Swissvale, Pa. The company was organized in 1883, with a capital of $1,500,000, and has been engaged in the manufacture of every known form of automatic and semi-automatic railroad signals. In the fall of 1863, Colonel Prout enlisted in a Massachusetts regiment. In the Army of the Potomac he went through the Wilderness Campaign. In 1865 he was mustered out, and two years later entered the University of Michigan, where he graduated with the degree of civil engineer. He had a few years work on railroad surveys and construction, and two summers were spent in taking surveys in the Rocky Mountains. After this experience, he entered the service of the Khedive of Egypt, as a major of engineers. He remained in that service about four years and a half and reached the grade of colonel in the general staff. After the first year, he went to the Soudan in command of an expedition to Kordofan and Darfour, and thence he was sent to the head of the Nile as governor-general of the provinces of the Equator. Colonel Prout's work here was largely administrative. He had 3,000 soldiers under him and was supreme over finance, civil, and military affairs. After his return to America, he was for a little over a year signal engineer to the company out of which the Union Switch and Signal Company grew. Colonel Prout was in business in the city of New York for a few years, and in March, 1887, became the editor of the *Railroad Gazette*. In recognition of Colonel Prout's splendid work as an editor and journalist, Yale University last year gave him the honorary degree of Master of Arts. Colonel Prout is not only a distinguished writer, but is a much sought after speaker and a splendid lecturer. Along with his journalistic work, Colonel Prout has done a great deal of consulting and expert work with engineers and officials of many important railroads. He is now the editor of the railroad division of the new volumes of the Encyclopedia Brittanica, is a member of numerous societies, clubs and associations and has served them all in some official capacity. Colonel Prout is an accurate, clear-minded critic, quick to grasp the gist of things and to follow up a point with a sound reason and a convincing statement.

## INDUSTRIAL ITEMS.

THE JEWELL ELECTRICAL INSTRUMENT COMPANY, Chicago, Ill., has ready its price list for January, 1903, descriptive of Jewell standard meters for direct current.

THE HADAWAY ELECTRIC HEAT AND ENGINEERING COMPANY, New York city, has removed from 107 Liberty street, and has established headquarters at 228 Broadway.

THE HAZARD MANUFACTURING COMPANY, Wilkes Barre, Pa., manufacturer of wire rope, insulated wire and copper wire, has selected a series of Dutch scenes for the pictorial panel on its new 1903 calendars. These are very attractive.

THE ATWATER KENT MANUFACTURING WORKS, Philadelphia, Pa., maker of the Monoplex telephones, is sending, on request, a small calendar, on which is printed a reproduction of a pen and ink Gibson study. The company is securing a good deal of new business and is to place in a short time several systems of intercommunicating telephones on the market.

THE UNITED TELPHERAGE COMPANY, 20 Broad street, New York city, issues an elaborate line of literature and illustrations detailing the remarkable range of operations which its apparatus covers. Apparently there is no field in any direction which has not been served by the electric telpher. This company's circulars are a liberal education on the applications of this modern machine.

HECTOR MACRAE, 316 St. Paul street, Baltimore, Md., is the manufacturer of the "Champion" storage battery or accumulator. These are built especially for gasoline engine ignition, and a notable feature is the small size and convenience, there being two binding posts, and a guarantee that it will hold a charge for six months if not used, and that it can be recharged an indefinite number of times.

THE MARSHALL-SANDERS COMPANY, Boston, Mass., has just finished its inventory of the year's business. This has shown a very large increase, and the orders for the new year are all that could be desired. The Marshall-Sanders Company has been in business but a short time, but it has been fortunate in placing upon the market several specialties for which there has been created a very popular demand.

THE ELECTRIC APPLIANCE COMPANY, Chicago, Ill., has issued for immediate distribution a new conduit catalogue. This is well arranged and is one of the most complete catalogues of its kind. Besides illustrating the complete line of "Toler" system conduit boxes, it furnishes a number of working diagrams, together with much valuable information along that line. This will be mailed on application.

*THE FOUR TRACK NEWS* for February, published by George H. Daniels, general passenger agent of the New York Central & Hudson River Railroad, keeps up the characteristic good appearance and valuable contents of this ambitious monthly. The size of this paper has been growing steadily since its first appearance, and there seems to be no reason why it should ever lose the popularity which it has gained in a very short time.

THE JOSEPH DIXON CRUCIBLE COMPANY, Jersey City, N. J., manufactures a special line of pencils which it designates as its "Car Inspector" pencil. This is noteworthy because of its quality and strength of lead. Where a great deal of work involving the use of a pencil is necessary, this pencil will no doubt be very acceptable. The car inspectors who have used them pronounce them in every way satisfactory for their work.

WESTINGHOUSE, CHURCH, KERR & COMPANY, Pittsburg, Pa., have secured a contract from the New York Edison Company for another 6,500-horse-power, vertical, three-cylinder, compound engine. This includes an independent steam-driven air and circulating pump. The aggregate of the eleven units delivered by this company to the New York Edison Company is 71,000 horse-power normal, and 100,000 horse-power maximum capacity.

THE UNION SWITCH AND SIGNAL COMPANY, Swissvale, Pa., is mailing a new catalogue—section 2—descriptive of its mechanical ground connections and leadout appliances, and also a bulletin descriptive of Kopp solid color glass for railway and marine signaling. This glass does away with the necessity of effecting colors in the lenses with the "plating," "casing," or "flashing" processes. This is a real red pot glass and its advantages will be readily recognized.

THE MECHANICAL BOILER CLEANER COMPANY, Chicago, Ill., has received a letter from Mr. John I. Beggs, president of the Milwaukee Electric Railway and Light Company, in which he states that he has now fifteen Garrigus cleaners in operation, is equipping eight more, and is gradually putting them on all of his boilers. He writes that his experience has been such that he commends the cleaner, and that its use has enabled him to more than double time between cleanings.

JAMES L. ROBERTSON & SONS, 204 Fulton street, New York city, are meeting with many testimonials as to the practical working of "Eureka" packing. The least pressure acts on the rubber core, causing it to expand or contract, making it suit the conditions prevalent where rods are scored or out of line. Great care is taken in preparing the lubricants used in the construction of "Eureka" packing. The different tests through which it passes ensure a lubricant of very high order.

THE HENDERSON ELECTRIC COMPANY, 1334 Montana street, Chicago, Ill., patentee and manufacturer of specialties for electric construction, has arranged with a number of large supply houses to handle these. Some of these houses are as follows: The Stuart-Howland Company, Boston, Mass.; H. C. Roberts Electric Supply Company, Philadelphia, Pa.; M. B. Austin & Company, and the Illinois Electric Company, Chicago, Ill.; and the Western Electrical Supply Company, of St. Louis, Mo.

THE A. A. McCREARY COMPANY, 136 Liberty street, New York city, manufacturer of the well-known McCreary half-shades, reflectors, desk lamps, etc., and one of the oldest electrical specialty houses, has been reorganized as the McCreary Electric Company. The new company has increased facilities for the prompt manufacture and delivery of electrical goods, and will materially enlarge its line. The company will be represented in Chicago, London and the Continent. Mr. A. A. McCreary, who has been identified with the electrical manufacturing business for the past twenty-five years, will be retained as president. Mr. Henry W. Brooks, Jr., of 44 Pine street, New York city, is the treasurer.

THE UNION SWITCH AND SIGNAL COMPANY, Swissvale, Pa., is mailing its catalogue, section No. 13, entitled "Battery and Relay Shelters." This illustrates and describes a number of battery and relay shelters manufactured by this company and in successful use on the principal railroads. The large rectangular box head of the recent form has been replaced by one of more compact and simple construction. The cover of the chute is entirely removable, not being secured to the head by hinges. A small lip, which projects down from one side of the cover, fits under the flange on the rim of the head, securing the cover thereto so long as the chute remains locked. This catalogue will be sent upon request.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., has prepared several new pamphlets regarding transformers which are not only elaborate in design, but which contain a very complete study of the subject. These are entitled, respectively, "Some Facts Regarding Type H Transformers," "Transformer Economy," and "Sheet Steel for Transformers." The pamphlets are devoted to the discussion of various points in the design and construction of transformers, and particular attention is called to the improvements in the operating efficiencies which have been made within the last few years. The heating guarantee on low-frequency transformers and statistics and curve sheets of trial runs are given in detail, and much valuable information is embodied in the three publications.

THE NEW YORK CENTRAL & HUDSON RIVER RAILROAD has recently placed an order with Westinghouse, Church, Kerr & Company for four Westinghouse-Corliss engines of the horizontal cross-compound type. These engines will form the main power equipment of a new power station in process of erection on the company's property at Weehawken, N. J., and will furnish power to the grain elevators and shops there located. The power equipment for a group of office buildings in lower Pittsburg, for furnishing light, heat and power, has also been partly contracted for by Westinghouse, Church, Kerr & Company. The contract includes two 1,500-horse-power, Westinghouse-Corliss engines, which are now under construction and which will be ready for delivery in about six months. These engines are of the horizontal cross-compound type, and will operate non-condensing, the exhaust steam being used for heating purposes.